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THE PAG BULLETIN

Purpose

The PAG Bulletin is published by the Protein Advisory Group of the United Nations System. Its purpose is to give information on the world protein problem to those individuals, academic institutions and industrial organizations which are interested in helping solve the protein problem and to promote the exchange of information in this field.

Mailing list

The PAG Bulletin is sent without charge to persons, organizations, and companies with an active interest in proteins. Requests to be added to the mailing list for the PAG Bulletin should be addressed to the Director of Secretariat, Protein Advisory Group of the United Nations System, United Nations, N.Y. 10017, U.S.A. Recipients are urged to share their copy with their colleagues.

Quotation

Permission to quote items from the PAG Bulletin is not required except from authors of signed articles. The Secretariat of the PAG would appreciate being informed of quotations made from the PAG Bulletin.

Suggestions

The PAG Bulletin will be successful only if it reflects all aspects of the protein problem comprehensively and objectively. The Secretariat invites suggestions and ideas for broadening and deepening the scope of the PAG Bulletin.

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NOTE BY THE SCIENTIFIC SECRETARY

A fortunate juxtaposition of circumstances has made it feasible to devote this issue of the Bulletin primarily to the subject of the food legumes. PAG Statement 22, "Upgrading human nutrition through the improvement of food legumes", prepared by a PAG ad hoc Working Group in July 1972, was modified and approved for release in December 1972 by the PAG Steering Committee Meeting at WHO in Geneva. This followed, by a day, a meeting there of the PAG ad hoc Working Group on Feeding the Preschool Child, which reviewed rather exhaustively questions relating to the advantages and precautions to be taken in feeding legumes and green leafy vegetables to young children. Accordingly, this "legume issue" provides a wide variety of information on the subject including a guideline for plant breeders seeking to introduce into their legume breeding programs recommended procedures for achieving nutritional and food-acceptance improvement of these food crops. It also includes critical assessment by pediatricians and clinical nutritionists of the advantages and some of the problems in preparing and feeding these protein-rich staple foods to infants and young children. The last step in this current round of interest by PAG will be the early release of a book "Nutritional improvement of food legumes by breeding", which is the proceedings of a symposium held in July 1972 at FAO in Rome.

IN THIS ISSUE .....

PAG STATEMENT (No. 22) ON UPGRADING HUMAN NUTRITION THROUGH THE IMPROVEMENT OF FOOD LEGUMES*

SUMMARY

The food legumes are major sources of protein and other nutrients in the diets of many developing countries and they often have a significant role in desirable crop rotations. These important food species have been seriously neglected in terms of research necessary to increase their yield and to correct certain defects in the nutritional and food-use qualities.

The PAG recommends urgent research attention to six major species of food legumes: dry beans, pigeon peas, cow peas, chick peas, broad beans, and peas; and the two leguminous oilseeds, peanuts and soybeans. While increased yield and improved consumer-acceptance qualities are primary objectives, priorities are also proposed for genetic improvement of various nutritional factors. These include increased protein concentration, higher methionine and cystine levels (the sulfur-bearing amino acids are usually the first-limiting amino acids in legume proteins, cystine having a sparing effect on methionine), augmented lysine where feasible (legumes are primary sources of lysine in cereal-based diets), and protein digestibility.

The importance of specific nutrients is indicated and the need for careful nutritional evaluation is emphasized. Various techniques for evaluating nutritional properties in breeding programs are listed and critically compared. These include total protein, methionine, cystine, total sulfur, and other amino acids. Also listed and evaluated are methods for digestibility and for toxic constituents, which are classified under heat-labile and heat-stable types. These include trypsin inhibitor (whose effect on humans may not be significant), the hemagglutinins, anti-vitamins, goiterogens, cyanogens, alkaloids, lathyrogens, and factors leading to favism and flatulence. The applicability and interpretation of feeding tests for various factors, including protein efficiency ratio and digestibility, are discussed. Bioassays for growth-depressing factors are also listed. Recommendations are presented for needed nutritional and biochemical research.

The attention of legume breeders is directed to the need for solutions to storage, processing, and consumer-acceptance problems in legumes under the headings of cooking, milling quality, susceptibility to insect infestation, undesirable storage changes, and uniformity of time of maturation of legume crops.

Production problems and opportunities are reviewed under the headings of breeding objectives, study of growth processes, production and management policies, and production economics and utilization.

The statement closes with emphasis on the importance of a reinforced program of food-legume research and training and the need for greater research support and stronger international cooperation.

1. IMPORTANCE OF FOOD LEGUMES

The food legumes** are important and economical sources of protein and calories

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*Issued 9 March 1973.

**The following definition of food legumes has been proposed by Roberts (1970): "Food legumes as here defined include those species of the plant family Leguminosae (pea or bean family) that are consumed directly by human beings, most commonly as mature, dry seeds, but occasionally as immature, green seeds or as green pods with the immature seeds enclosed. It does not include species that provide leaf or stem tissue that is used as cooked or uncooked greens. Food legumes utilized as dry seed are often referred to as pulses or grain legumes."

as well as of certain vitamins and minerals essential in human nutrition. However, the significant role they play in the diets of many developing countries appears to be limited by their scarcity, caused in great part by their present low yields, their consequent cost, and certain defects in their nutritional and food-use qualities.

Information on regional and world production of food legumes is given in Table I. When analyzing these data, the reader should recognize that the species listed other than soybeans and peanuts are consumed directly as human food. The bulk of these two leguminous oilseeds, which are produced in far greater amounts, is processed for edible oil and for protein residues used largely for animal feeding, primarily in the industrialized countries. The availability of selected food legumes in terms of grams per caput per day for various countries in different regions is shown in Table II, and projections of demand for certain dry legumes between 1965 and 1980 appear in Table III. The increasing trend in demand in the developing countries is shown by two methods of projection.

Improvement of most of the food-legume crops used primarily and directly for human food has been greatly neglected. In fact, the "Green Revolution" will not be complete until breakthroughs are achieved with these food crops similar to those accomplished with the cereals (UN Strategy Statement, 1971). There is an obvious need for guidelines to stimulate efficient global progress towards realizing these objectives.

The PAG is primarily concerned with the improvement of diets deficient in protein, and stresses the unfulfilled nutritional potential of food legumes for improving human diets as well as their economic advantages, particularly in developing regions. The food legumes have primary importance for:

a) Complementing and supplementing the protein-deficient diets generally prevailing among populations in urban, suburban, and rural areas, including subsistence farmers, particularly in developing regions.

b) Providing economical protein concentrates as ingredients for processed, nutritious foods, including foods for weanling and preschool children.

c) Raising the income of agricultural producers by making these crops competitive with other food staples.

It must be emphasized that the first order of priority in approaching these objectives will be the improvement of productivity, adaptability, and yield stability. The second is improving the acceptability and food value of legumes as carriers of nutrients lacking in many diets, and reducing the concentration of certain undesirable constituents. The main protein-nutritional deficiencies of food legumes arise, in general, from a low sulfur-amino acid content. In addition, some of them contain toxic principles and some may cause flatulence. Limited digestibility may also be an important problem. Many are deficient in organoleptic qualities, such as flavor and color, and in desirable cooking characteristics. Factors requiring improvement should be considered in the context of total diets wherever legumes are accepted and where traditional home cooking practices are used. Here, improved varieties can have an important impact on the total food supply in a country.

The PAG stresses that agronomic problems in food-legume production are very different from those with cereals, which were solved by the new high-yielding varieties. The Green Revolution in cereal production was based primarily on the favorable responsiveness of such varieties to nitrogen fertilization under irrigation, whereas legumes play a quite different but important complementary role in cropping systems by virtue of their capacity to fix nitrogen.

2. PRIORITIES IN FOOD - LEGUME IMPROVEMENT

Considering the large number of existing food legumes, it is necessary to select those species which possess the greatest potential for significant contribution to the diets of people in the major ecological zones of the developing

regions. The following are therefore recommended for urgent and immediate attention by all concerned agencies and institutions:

a) Dry beans (Phaseolus vulgaris) for intermediate and higher elevation tropics and drier irrigated conditions.

b) Pigeon peas (Cajanus cajan) for humid to semiarid, low to intermediate elevation tropics.

c) Cow peas, niébé, or Southern peas (Vigna sinensis; V. unguiculata) for semiarid to subhumid lowland tropics.

d) Chick peas (Cicer arietinum) for cooler environments, including the higher elevation tropics and Mediterranean winter-spring seasons.

e) Soybeans (Glycine max)* for the subhumid and humid, low and intermediate elevation tropics, and irrigated dry seasons.

f) Broad beans (Vicia faba) for higher elevations and Mediterranean winters.

g) Peas (Pisum sativum) for intermediate to high elevation tropics, and as a winter crop in Mediterranean-type ecologies.

h) Groundnuts (Arachis hypogaea)* for the semiarid and low and intermediate elevation tropics.

Other food legumes that have not yet achieved equally widespread importance are Asian grams (Vigna radiata and V. mungo), lentils (Lens esculenta), lupines (Lupinus spp.), yam beans (Sphenostylis stenocarpa), lima beans (Phaseolus lunatus), jack beans (Canavalia ensiformis), bambarra groundnuts (Voandzeia subterranea), and others. These species exhibit specific useful features of adaptation and nutritional value and should be given appropriate local attention. As their value becomes better defined they may achieve major significance.

This statement seeks to identify and define those food-use and nutritionally related problems inherent in food legumes that plant breeders should consider when developing well-planned programs for genetic improvement of these crops, and it suggests techniques for evaluating and screening crops for these factors. It goes on to propose how production problems may be overcome through genetic improvement and better cultural practices, when such means are available, and indicates areas in which more research is necessary.

3. GENETIC IMPROVEMENT OF NUTRIENT COMPOSITION AND DIGESTIBILITY

Within each of the important legume species, the range of genetic variability, as well as the effects of environment on this variability, should be determined in relation to various nutritional factors. The factors listed below in an order of priority varying with feasibility in individual species (Roberts, 1970) should be emphasized in breeding-improvement programs:

a) Protein concentration. This attribute should be increased or maintained at the highest level possible, while efforts are made to achieve higher crop yields and to retain or improve protein quality.

b) The first-limiting amino acids. These are usually methionine and cystine (except for Cajanus, in which tryptophan is probably equally limiting), which should be increased if possible. These sulfur-bearing amino acids should be considered together because methionine may be utilized to supply cystine requirements.

c) Protein digestibility. This varies to some extent depending on species and is not poor overall, but for some food legumes it needs improvement.

d) Nonlimiting essential amino acids. The normal lysine content of legumes does not limit their nutritional value as does the characteristic

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*The two leguminous oilseeds are considered here for their exceptional potential as food-protein sources (Noachovitch, 1969).

methionine deficiency. However, inasmuch as lysine is generally the first-limiting essential amino acid in diets dominated by cereals, every effort should be made to retain or increase legume lysine levels.

e) Other essential amino acids (e. g., threonine). If they are likely to become limiting in the overall diet as the primary limiting amino acids are increased to the point of sufficiency, consideration should be given to increasing their level as well in the legumes.

f) Minerals (e. g., Zn, Ca, Fe) and vitamins should be maintained at the highest level possible.

Because legume species are used in many different diets, it may be necessary to reorder the above priorities to fit a particular regional dietary need. Thus, as indicated, where legumes are consumed with cereals it may be more important to improve lysine levels than methionine/cystine, but where legumes are consumed with starchy roots or tubers, methionine/cystine improvement would be more significant.

It must be established that any genetic changes introduced will not adversely affect other nutritionally beneficial constituents or increase antinutritional factors (e. g., excessive amounts of other essential amino acids, potentially competitive nonessential amino acids, and toxic inhibitors). Before incorporating any compositional change, except total protein, it should be established that the factor will be reflected in improved overall nutritional value of the diet (see para. 4) and that it is heritable in the legume species. Improvement of amino-acid balance and protein digestibility in legumes intended for animal feeding also should not be overlooked.

Breeding programs should emphasize improvement of yield, adaptability, total protein (for those crops in which significant protein variability has already been established), and consumer acceptability. Fundamental genetic studies for the selection of breeding populations with higher levels of total protein and amino acids should be conducted parallel to the agronomic improvement and breeding programs. These more nutritious lines can be introduced into the program as soon as the previously indicated requirements have been fulfilled and when enough is known about their mode of inheritance to facilitate rapid incorporation into otherwise superior agronomic types. Such studies may reveal undesirable linkages, quantitative inheritance patterns, or physiological associations that make the incorporation of the nutritional factors difficult or unfeasible.

Existing populations should be exploited wherever possible to introduce protein improvements into currently used varieties or to furnish substitutes for currently used varieties. Where suitable needed genotypes cannot be found in existing breeding stocks, attempts should be made to induce them by other known means. For each crop, goals for protein-nutritional improvement should be established and certain minimum levels of some amino acids should be set as practical objectives. In addition, standard reference varieties should be established and maintained for each crop. Biochemical studies to elucidate the nature and causes of differences in protein patterns, amino-acid balances, and protein digestibility should be encouraged.

4. EVALUATING NUTRITIVE PROPERTIES OF LEGUMES

Because legumes are to be used as human food and because breeding programs can produce wide variation in the content of both nutrients and toxic substances, careful nutritional testing by reliable techniques must have high priority in any development program. Reference should be made to two comprehensive protocols, one dealing with preclinical testing of novel sources of protein (PAG Guideline 6) and the other with human testing of supplementary food mixtures (PAG Guideline 7). While Guideline 6 refers primarily to unconventional protein sources and food mixtures based on them, its principles are directly applicable to assessment of the safety and nutritional quality of new legume cultivars as well.

The objective of this portion of the statement is to indicate techniques for evaluating the specific nutritive properties which should be of concern to the plant breeder. Some of these are deemed important enough to merit a place in routine programs for examination of new breeding lines. Other nutritive properties, although important, are not yet amenable to procedures that can be adapted readily to a rapid plant-breeding screening program. Some tests are recommended only at later stages of the breeding process, after selections have been made according to other criteria.

4.1 Protein content

This seems to be the only nutritional criterion that can be employed with early generation material or with any very large series of samples. An attempt should be made to establish if a correlation between dye-binding capacity (DBC) and Kjeldahl nitrogen content (AOAC, 1950) exists (e.g., Hymowitz, et al., 1969; Mossberg, 1969, 1970). The DBC can be measured with the Udy Protein Analyzer (Boulder, Colo., U.S.A.) and, when the samples are too numerous for classic Kjeldahl analysis, the Technicon or Carlo Erba (Milan) analyzers can be employed in micro-Kjeldahl nitrogen determination (e.g., Varley, 1966). In the latter case, a protein conversion factor of 6.25 is recommended for comparative purposes only, and does not imply true protein content, which may be somewhat different (Thurman and Boulter, 1966; Smith, 1966). Consideration should also be given to the use of such techniques as infrared analysis when suitable instrumentation becomes available and its accuracy proved (Rosenthal, 1971). High nitrogen values per se may not be indicative of protein of desirable quality, as some species may contain disproportionate amounts of certain amino acids. Ultimately, a biological test for nutritive quality is essential in any screening program.

4.2 Amino acids

The deficiency or lack of availability of the essential amino acids methionine and cystine are of primary concern in most legumes. Appropriate analytical methods for these have been proposed. Sulfur content is under study as an indicator of these amino acids. Lysine and tryptophan are normally present in adequate amounts but opportunities for increasing them should not be neglected. Analytical methods for these amino acids are available.

4.2.1 Methionine. This amino acid, together with cystine, constitutes the first-limiting amino acid of legumes (FAO,1970; Swaminathan, 1967). Hence both these acids should be determined, if possible. Specific procedural recommendations, however, cannot be made because the method of choice will depend on the facilities available in each laboratory. The following assay methods are suggested:

a) Ion-exchange chromatography. For limited numbers of samples, this method is accurate and reproducible (Moore and Stein, 1963; Spackman, et al., 1958; Devenyi, 1971).

b) Gas-liquid chromatography of amino acids as N-trifluoracetyl n-butyl ester derivatives. This method was shown to be as accurate as ion-exchange chromatography, and it is cheaper and faster to run (Gehrke, et al., 1968, 1971; Mottershead, 1971; Basson and Bochmair, 1972).

c) Microbiological assay. Although less precise, this method does have the advantage of simplicity and speed, and, in the hands of experienced personnel, can yield very useful data (Kelly, et al., 1970).

d) Automated color assay. Although an automated color assay for methionine has been proposed, its validity remains to be established (Gehrke and Ussary, 1969; Ussary and Gehrke, 1970). Such a procedure would be extremely useful, and continued efforts to improve it should be strongly encouraged.

e) Other chromatographic techniques. Rapid techniques for the measurement of methionine by thin-layer chromatography (Ferenczi, et al., 1971) and paper electrophoresis are currently under investigation, but their applicability to the present problem remains to be determined.

4.2.2 Cystine. The total S-containing amino acids are of great importance in the diet, so a knowledge of the cystine content of legumes could be very desirable. Unfortunately, rapid, reliable assay methods for cystine are not available. Cystine may be determined as cysteic acid if an automated amino-acid analyzer is available (Spackman, et al., 1958; Hirs, 1967). It is hoped that more rapid techniques for the analysis of cystine will be forthcoming, and efforts in that direction should be strongly encouraged.

4.2.3 Total sulfur. If this analysis proves to be a useful, direct measure of methionine plus cystine, it will be a great convenience (Boulter, et al., 1973). Rapid automated techniques are available for total S analysis (Mottershead, 1971; Basson and Bochmair, 1972). Investigations are being carried out on the applicability of the Leco Sulphur Analyser for legume foods (Boulter, et al., 1973).

4.2.4 Other amino acids. Because legumes can serve as a valuable source of lysine for supplementing cereal-containing diets, a knowledge of the lysine content would be most valuable. Although not recommended on a routine basis, lysine analysis should be carried out at some later stage of the screening process. This analysis can be done by one of several available colorimetric methods. However, their convenience and accuracy may vary with the material analyzed (White and Gouger, 1967; Villegas and Mertz, 1971). Tryptophan, which may be a limiting amino acid in some diets, likewise can be assayed by simple colorimetric techniques (Spies, 1968; Villegas and Mertz, 1971) that also need improvement in accuracy and versatility.

4.2.5 Digestibility. Simple in vitro digestibility techniques are available (Sheffner, 1967) but cannot be recommended until such results are correlated with digestibility data obtained from animal experiments.

4.3 Toxic constituents

Although numerous toxic constituents are found in raw legumes (Liener, 1969), many of them are destroyed by adequate heat treatment, such as might be employed in common cooking procedures prior to consumption. It becomes important, therefore, to establish those processing conditions which are necessary to inactivate or eliminate these toxic constituents; this evaluation should be done as a minimum procedure on parental breeding material and at later stages of selection on more advanced material. Other toxic constituents may be heat-stable and these also should be looked for. Specific recommendations for screening purposes are listed below with appropriate remarks.

4.3.1 Heat-labile factors that need not be screened for initially:

a) Trypsin inhibitor. i) Normal cooking is considered sufficient to destroy the trypsin inhibitor. ii) There is a strong indication that legume trypsin inhibitors may not be physiologically active in man. This is based on recent in vitro evidence which shows that human trypsin, unlike bovine trypsin, is only weakly inhibited by the soybean inhibitor (Feeny, et al., 1969; Coan and Travis, 1971). iii) Retention of trypsin-inhibitor activity in legumes might be desirable, because it may serve as a defense mechanism against insect infestation during storage (Birk, et al., 1963; Lipke, et al., 1954; Guen and Ryan, 1972). Further research is needed to establish the validity of this thesis. iv) The trypsin inhibitor in its inactivated form may serve as a good source of the S-containing amino acids, as these proteins are known to be very rich in cystine, although it is unavailable in the raw bean (Kakade, et al., 1969).

b) Hemagglutinins. Routine examination for hemagglutinating activity is not recommended, but once selection of lines has been made, proper conditions of food preparation necessary to destroy the hemagglutinins should be established. The significance of these substances in human nutrition has not yet been established and they are definitely toxic to rats and chicks (Jaffé, 1969), so it is recommended that continuing efforts be made to breed legumes (particularly *Phaseolus*) which have low hemagglutinating activity.

c) Antivitamins and metal-binding components. The antinutritional effects of these components

should be determined in the final selection procedures by biological assay. In some cases, these factors can be counteracted by dietary supplementation and/or cooking (Liener, 1969).

d) Goiterogens. There are no known screening methods for goiterogens. The goiterogenic effects produced by soybeans and peanuts (Van Etten, 1969) can be counteracted effectively by dietary iodine supplementation (e.g., in salt) and/or cooking.

4.3.2 Heat-stable factors

a) Cyanogens. The presence of cyanogenic glycosides in legumes (Montgomery, 1969) does not constitute a health hazard, with the possible exception of *Phaseolus lunatus.* The most commonly used edible varieties of this bean, however, are quite low in cyanide content. Any newly introduced varieties of this legume should be analyzed for their potential cyanide-producing capacity before being released for human consumption.

b) Alkaloids. Although relatively few legumes are known to contain toxic alkaloids (with the possible exception of *Lupinus*), their presence should be ascertained in the development or introduction of any new, improved varieties of legumes derived from parent material devoid of them (Tanners, et al., 1968).

c) Unidentified factors. See "Feeding tests" below.

4.3.3 Toxic factors of special interest.

a) Lathyrogens. Relatively simple techniques are available for destroying the neurotoxins of *Lathyrus sativus* (Sarma and Padmanaban, 1969). However, further research on the development of strains or varieties of *Lathyrus* deficient in the neurotoxin believed to be responsible for human lathyrism (β-N-oxalyl-α, β-diaminopropionic acid) should be encouraged. Further research on the causative factors of human lathyrism also is needed. During the course of such breeding studies, however, it should be remembered that other neurotoxins (e.g. α, γ-diamino-butyric acid and β-cyanoalanine) may be present.

b) Favism. The development of lines of *Vicia faba* that are free of the causative factor(s) of favism should be delayed, pending positive and complete identification of the toxic factors (Mager, et al., 1969). Efforts to identify the causative principle(s) of favism therefore should be continued. From such studies may also emerge a simple analytical technique which can be used for the purpose of screening strains of *Vicia faba.*

4.4 Flatulence factors

These do survive ordinary cooking and they might be considered by some consumers to be crucial factors limiting acceptance of increased proportions of certain legumes in diets (Berk, 1968). When legumes are consumed in large quantities, especially by young children, flatulence may cause considerable inconvenience. This limits their consumption but, if the legumes are well-cooked, children can eat them. They should be introduced in small amounts and gradually increased as the child becomes adapted or accustomed to the new preparation (PAG, 1973; Narayana Rao, et al., 1972). It would be advantageous, however, to have varieties with lower flatulence activity, and research that leads to development of simple assay methods for this factor would be useful.

4.5 Feeding tests

The true nutritive value of any legume can be checked finally only by animal assay, taking into account the necessary prior chemical and biochemical evaluations recommended in PAG Guideline No. 6. It is recognized, however, that such assays cannot be part of a routine screening procedure. Until now, this type of assay has been done mainly with young rats. Other small animals, however, such as mice and voles (*Microtus pennsylvanicus*), may prove equally suitable for this purpose (Elliott, 1963; Rios Rirarte, et al., 1972), but before a species other than rats is selected for use with legumes it should be clearly established by prior standardization that reliable results will be obtained and that responses are comparable. Recent Canadian

studies suggest that the vole assay may be too insensitive to use as a screening method (private communication). Bioassays also have employed other organisms, such as bacteria (Ford, 1962), protozoa (Bayne, et al., 1967), insects, etc., for some types of tests, but these procedures may have limited usefulness in replacing tests with mammalian or avian species. The meaning of these tests is often open to question so more emphasis must be placed on the determination of available amino acids. However, they deserve to be investigated further as they might be developed as screening "indicators."

For any legume species for which there is evidence that cooking improves nutritional value (e.g., by inactivating toxic factors), feeding tests should be carried out with material subjected to a specific standardized cooking procedure adapted to each species or new strain of legume. While one convenient procedure suitable for Phaseolus vulgaris is to autoclave (in open steam) in shallow (2-cm) layers at 15-lb pressure for 15 minutes, such conditions do not simulate actual cooking procedures in developing countries, where beans are cooked in an open pot.

a) PER. The commonest procedure has been to measure protein efficiency ratio (gram weight gain per gram protein eaten) with rats (McLaughlan and Campbell, 1970). The test material is included in the diet at a level contributing 10 per cent protein to the diet (N x 6.25), and is the only source of protein. Thus a legume with a 25 per cent protein content is included as 40 per cent of the diet. The standard method requires 28 days; we recommend 10 days as being adequate for screening, using 6 rats per treatment. To reduce the possible effect of food intake it might be advantageous to use the net protein ratio assay with a negative control group (NAS/NRC, 1963).

b) Modified PER. Because of low methionine content, the PER is always very low in legumes as compared to the result obtained with a protein source of well-balanced amino-acid composition and no toxic properties. If the methionine content of the material is being determined separately in any case, and one can afford only one feeding test for any particular sample, it may be preferable to carry out a PER determination with added methionine (or with methionine plus tryptophan, in cases where both are limiting). A high result from this type of test confirms both that no amino acid other than methionine (or methionine plus tryptophan) is seriously deficient in the protein and that the cooked legume contains nothing that seriously depresses a rat's growth or appetite. If the results are unusually low, it would indicate either a low level (or destruction) of another essential amino acid or the presence of a heat-stable toxic factor (Kakade and Evans, 1966; Bressani, et al., 1963).

c) Digestibility. This can be determined as part of a PER (or modified PER) assay (McLaughlan and Campbell, 1970). The overall digestibility of the legumes can be estimated from the weight of feed and fecal dry matter and the digestibility of protein by feed and fecal analysis for N (McLaughlan and Campbell, 1970).

4.5.1 Nutritional value in complete diets. Another indication of the nutritional value of a food legume can be determined at a later stage in varietal testing with rats by feeding them a diet that contains the test legume in combination with other staple food components regularly available and used by populations in a given area. The nutrient content of the components of the test material should be utilized in formulating the diet, and any obvious or recognized deficiencies should be corrected. Variations in the test could be made by feeding the diet with and without those supplementary nutrients suspected to be limited.

4.5.2 Assays for growth-depressing factors. These additional tests could be used for special investigations:

a) Heat-stable, growth-depressing factors. The biological test for presence of heat-stable, growth-depressing factors can be conducted by feeding at least a 50 per cent level of autoclaved test material (Kakade and Evans, 1966; Bressani, et al., 1963). This should replace an equal weight of a standard mixture of casein and starch or sugar of the same protein content. The diet should be well-balanced and adequate in all respects.

As a further extension of this test, a diet containing the test material could be fed with and without the supplement of an antibiotic such as penicillin or tetracycline (Goatcher and McGinnis, 1972). This would give an indication of the presence of growth-depressing factors that are counteracted by antibiotic supplements. Rats and chicks are suitable animals for this test.

b) Heat-labile factors. A biological test to ascertain the presence of heat-labile, growth-depressing factors can be conducted with rats, mice, or chicks. In effect, it is the same as that for heat-stable factors (see above). Forty to 50 per cent of the test diet should be autoclaved and replace that amount of sugar or starch. Use the same proportions with raw test material. Influences on growth as a result of the cooked and the raw materials can then be measured.

4.6 Relevant areas of nutritional and biochemical research

a) Methodology

(i) Protein. The new infrared methods should be tested critically for their applicability to grain legumes of all types.

(ii) Sulfur-amino acids and total S. Intensive study is needed to find more sensitive procedures that can provide meaningful results with large numbers of samples.

(iii) Rapid biological tests. There is a need for reliable procedures that can use species that require less food than rats.

(iv) In vitro digestibility tests. In vitro tests of limited value are available (Sheffner, 1967). There is a need for studies on the correlations of results from these tests with those from in vivo tests or content of available essential amino acids.

(v) In vitro assay for flatulence factors. This would be of value, considering the desirability of increasing the consumption of legumes by younger age groups.

b) Other research

(i) Identification of flatulence factors and growth-depressing factors for chicks. Efforts should be expanded to identify the components in food legumes that cause flatulence in man and cause growth depression and diarrhea in young chicks.

(ii) Nutrient composition of legumes. All opportunities should be used to increase our information on detailed nutrient content (amino acids, carbohydrates, fats, vitamins, minerals, energy) of legumes. Research should be encouraged to provide for this type of work.

(iii) Relation of protease inhibitors and hemagglutinins to resistance of legume seeds to insect damage. Reports have indicated that the presence in seeds of such proteins as the protease inhibitors reduces their susceptibility to attack by some insects (Birk, et al., 1963; Lipke, et al., 1954; Guen and Ryan, 1972). This should be investigated further to establish the validity of these reports and to determine whether insect-resistant properties might be utilized to enhance storage properties.

(iv) Further studies of the causative factors for lathyrism and favism in man. Even though progress has been made, the compounds so far identified may not be the only ones responsible.

5. STORAGE, PROCESSING AND CONSUMER ACCEPTANCE PROPERTIES OF FOOD LEGUMES

Improving the home preparation and commercial processing characteristics and the consumer acceptance of legumes poses a series of problems for the plant breeder. These relate primarily to local food patterns and eating habits, which may vary not only from country to country but also within regions of a country. Conversely, they might be common for entire large ecological zones. This obviously implies that before any apparently desirable change can be introduced, it will be necessary to know in some depth the local food habits and preparation methods of

food legumes. The contribution and cooperation of local food scientists, nutritionists, home economists and perhaps of social scientists are essential.The main considerations to which the plant breeder can make a contribution are: uniformity in crop maturation; cooking quality and acceptability; milling or processing characteristics; susceptibility to insect infestation; and storage stability.

5.1 Cooking

This appears to be the universal and preferred way of preparing legumes for consumption. Most food legumes require 3 to 4 hours of ordinary boiling to cook properly; others are adequately prepared in half that time. The long cooking required for most legumes necessitates the expenditure of fuel, which is frequently scarce, and probably causes significant destruction or modification of nutrients. Therefore, when breeding programs are evolving improved strains, they should include better cooking qualities and acceptability. The newly developed strains also should meet the organoleptic (taste and flavor) requirements of the population. Parameters to be considered in acceptance tests carried out with local consumers are: texture, taste, flavor, and color. In such efforts, plant breeders should work in close association with food technologists.

5.2 Milling quality

The milling quality of food legumes varies widely, due to varietal and agroclimatic characteristics. The presence of gums between the husk and cotyledons determines the extent to which the husk adheres to the endosperm. Large-seeded varieties of legumes can be milled more easily than small- and medium-seeded types and require less drastic pre-milling treatments. Milling characteristics and yields also appear to be better with loose-husked varieties. There seems to be a need, in areas where the legumes are consumed in the form of flour or split grains, to develop strains with better milling characteristics, specifically large, uniform seeds.

5.3 Insect infestation

Insect infestation and mold growth during storage of legumes are often major problems in those developing countries with warm and humid climates, and result in significant losses, both quantitative and qualitative. Insect infestation decreases the nutritive value of legume proteins and also reduces milling yields. Thus, breeding for resistance to insect and mold attack should be considered in cooperative efforts between entomologists and plant pathologists. Control of mycotoxin development, such as aflatoxin, may be possible by such genetic means.

5.4 Changes on storage

Undesirable changes in some legumes result from prolonged storage. Among these are i) significant alteration in color, ii) reduced digestibility and acceptability, and iii) hardening of the seed, which requires increased cooking time. Attempts should be made to breed varieties that show minimal storage changes of this kind.

5.5 Uniformity of maturation

Uniformity in time of maturation is important for the commercial producer, and availability of strains with this desirable property might reduce considerably the processing costs, increase processing yield, and provide products more acceptable to the consumer. On the other hand, food legumes produced and consumed by the subsistence farmer and his family may require varieties which yield edible products during an extended period.

6. PRODUCTION PROBLEMS AND OPPORTUNITIES

Approaches recommended for overcoming various production problems are classified and discussed under the headings of breeding objectives, study of growth processes, production and management practices, and production economics and utilization.

6.1 Breeding objectives

The low productivity of most food legumes is generally recognized as a major deterrent to increasing their production and making them

competitive with other crops. It is therefore proposed that breeding efforts be concentrated in the following areas:

6.1.1 Improving productivity.

a) Higher yield. The first priority in all food-legume improvement is to increase yielding capacity per se. This may best be accomplished through changing the plant structure genetically and thereby increasing the harvest yield index (grain yield). Population improvement and recurrent selection should be used as tools in attaining such objectives.

b) Stability of yield. It will be essential to build into new, improved stocks the widest possible adaptation to prevalent soils and climates and broad-based resistance to pests and diseases to achieve a consistently high or dependable level of performance.

6.1.2 Improving product quality. Breeding objectives relating to acceptability, palatability, elimination of toxic principles, and increased nutritional value have been discussed previously, as have chemical and biological testing methods. In this context, it cannot be overemphasized that more rapid and efficient screening methods are needed urgently. Automation and increased capacity of present methods and development of nondestructive single-seed analysis to facilitate early generation screening also are vital needs. It should also be noted that the most efficient screening methods for biochemically related factors would include those in which readily observable morphological characteristics of seed or green plants are closely linked to or pleiotropically controlled by common gene(s) that also affect the biochemical constituent. Examples of such characters are the opaque and floury endosperms, which are characteristic of high-lysine maize; large embryos and lowered specific gravities of high-oil seeds; and the dark-colored seed coats associated with tannins and other phenolic compounds in both cereals and legumes. Plant scientists should search for and apply such useful associated morphological characters.

A better understanding of the basic processes of the biosynthesis and translocation of plant and seed storage proteins could lead to more efficient screening techniques. Research in this area should be encouraged.

6.1.3 New breeding methodology. Breeders and their colleagues in related disciplines should keep abreast of the most advanced developments in breeding technology and improved screening methods, including:

a) Better methods of population improvement for self-pollinating species, with emphasis on genic male sterility or the use of chemosterilants to induce maximum recombination of characters. Entomologists should participate in the search for and utilization of more efficient pollen vectors.

b) Broadening the genetic base. Several methods are proposed and would include:

(i) As deemed appropriate, wide crossing at the intraspecific level (diverse and weedy types), and with wild relatives and other species and genera in special circumstances.

(ii) Induction of mutations by radiation and chemical mutagens, especially to improve specific simple characters in adapted, elite materials.

(iii) Chromosomal engineering, involving whole chromosome or segment transfer, ploidization, and other techniques.

c) Advanced genetic manipulative techniques. These should include induction of haploidy, redifferentiation processes, tissue culture, protoplast fusion, and other methods.

6.1.4 Assembling, maintaining, and evaluating genetic resources. Assembly, collection, maintenance, and evaluation of a complete range of the genetic diversity in the major food-legume species is of paramount importance. Such a project is essential to prevent loss of valuable traditional genetic materials through replacement with improved strains and varieties and the destruction of wild habitats through population pressure and other factors. The collection of genetic material in previously neglected areas, such

as tropical Africa, should be accorded the highest priority.

Legume improvement programs that are assigned the responsibility for particular ecological zones should collect, assemble, and maintain all available, genetically-diverse food legumes grown in that zone. However, they would not necessarily evaluate and develop the collections of minor or secondary species, which should be maintained in holding nurseries or placed in appropriate storage against possible future need. In "major" species, the following programs should be supported:

a) Assemble available genetic stocks from ongoing breeding programs.

b) Undertake the systematic collection of those species in important and growing regions and centers of genetic diversity.

c) Eliminate duplicates and evaluate for important agronomic, botanical, and biochemical characteristics over a broad range of environments.

d) Develop genetic pools and populations for specific objectives and uses, including yield, adaptation to specific soils and environments, increased protein content, improved nutritional properties, resistance to insects and diseases, etc.

e) Develop a uniform system for recording and retrieving information on genetic resources.

6.2 Study of growth processes

Supportive investigations on growth and development processes in food legumes are recommended as an essential adjunct to the overall process of improvement which plant physiologists, agronomists, biochemists, and breeders share in the search for more basic understanding of growth processes in relation to environmental influence. An important aspect of these investigations would be the systematic search for more efficient genotypes in terms of plant architecture, response to stress, and inherent photosynthetic and respirational efficiencies. Among the many kinds of investigation needed are those on a) carbohydrate accumulation; b) nonphoto-respiration; c) response to daylength, insolation and temperatures; d) monitoring respirational pathways; e) intermediate pathways in protein synthesis and translocation; f) moisture and plant development relationships; g) hormone factors influencing vegetative/reproductive cycles and fruit abortion; h) rhyzobial nitrogen-fixing process; and other factors.

6.3 Production and management practices

Improvements in cultural practices and management are essential to sustain progress in legume improvement. Specifically, investigations in this field should include:

6.3.1 Cultural practices. These embrace studies on tillage practices, planting methods, population dynamics, intercultivation, cropping systems, and other factors under different environments and for different genotypes.

6.3.2 Fertility aspects. Realizing that the Green Revolution in cereals is related primarily to the responsiveness of high-yielding varieties to improved soil fertility, and especially high levels of nitrogen fertility, it should be stressed that legumes derive their nitrogen largely from symbiotic bacterial processes. Special attention must therefore be given to responses to bacterial inoculums, different major and minor plant nutrients, different soils and seasons, management factors, methods of placement, and genotypes.

6.3.3 Control of pests and diseases. Insects, diseases, and other pests are frequently major constraints to productivity. Effective and economical controls utilizing cultural practices, biological agents, and chemicals should be developed for different environments, seasons, genotypes, and other conditions.

6.3.4 Harvesting, processing, and storage. Efficient methods of harvesting and processing are required for developing regions. Inexpensive drying and storage will be essential in maintaining seed viability and food-use quality, and stabilizing the availability of food supplies throughout the year.

6.4 Production economics and utilization

Successful expansion of food-legume production will depend ultimately on incentives for producers, marketing economics, and product demand and utilization factors. These may be components of specific national policies relating to food production and nutrition objectives. Indirect benefits may include effects on soil fertility and tilth, crop rotation advantages, control of weeds, and availability and use of byproducts for animal food production. Economic studies should be carried out on cultural practices, including utilization of fertilizers, pesticides, and other direct inputs, relative to returns obtained from different legume genotypes grown in different environments and locales or countries. Reassessments will need to be made for new varieties as these are developed.

The introduction of new crops (e.g., soybeans in tropical Africa) and new types of familiar species will succeed only if these fit into local consumption patterns and food preferences. The exception would be those grown specifically for industrial purposes or export. Thus, it is considered most important, if not essential, to determine local consumer acceptability for these new food crops and varieties. In analyzing these findings, a basic understanding of sociological factors could be highly important.

7. POSSIBLE MEANS TO ACHIEVE A BREAKTHROUGH IN FOOD LEGUME IMPROVEMENT

The PAG recognizes the extraordinary success of the Green Revolution in cereal improvement and recommends the emulation of those features appropriate to improvement of the food legumes. It is suggested that the most efficient vehicle for achieving similar results would be a series of international technical networks (national research programs cooperating with international regional institutions and other international and national agencies) designed to collaborate with, strengthen, and serve all concerned national programs. One or more major centers for different ecological zones should be designated. There knowledge and resources could be pooled to catalyze research and training activities.

Organizing trials and experiments, distributing genetic stocks, disseminating information, holding regular meetings and workshops, training young scientists, and consulting on problems and future strategy as well as on nutrition are essential features of food-legume improvement programs in developing regions. Workshops (e.g., on regional crops) should be organized on a yearly basis; larger conferences and symposia may not be necessary more frequently than once every three to five years. The training of young scientists and production specialists is fundamental to the multiplication of efforts and the wider dissemination and adoption of specific research advances.

8. RECOMMENDATIONS ON INTERNATIONAL COOPERATION AND SUPPORT

The PAG emphasizes the importance of a continuing and reinforced program of food-legume research and training and calls for international action involving cooperation among interested international and national agencies and programs, institutions in developed countries, and international and national programs in developing countries. It is further recommended that such programs be accorded high priority for support from the Consultative Group on International Agricultural Research and other interested research-fund donor agencies.

TABLE I. REGIONAL AND WORLD PRODUCTION OF FOOD LEGUMES*

(Figures = 1000 metric tons)

		Dry beans (Phaseolus vulgaris)	Dry broad beans (Vicia faba)	Dry peas (Pisum sativum)	Chick peas (Cicer arietinum)	Pigeon peas (Cajanus cajan)	Cow peas (Vigna sp.)	Soybeans (Glycine max)	Groundnuts in shell (Arachis hypogaea)
West Europe	1970	647	890	272	168	-	6	-	19
	1971	603	826	263	140	-	6	-	21
	1972	609	809	262	130	-	6	-	21
East Europe and USSR	1970	283	23	5319	1	-	-	707	3
	1971	320	23	5069	2	-	-	721	3
	1972	321	25	5405	2	-	-	810	3
North America	1970	836	-	223	-	-	18	30957	1351
	1971	814	-	277	-	-	20	32285	1363
	1972	896	-	154	-	-	20	35054	1492
Latin America	1970	3830	164	107	180	33	-	1966	1382
	1971	3725	168	106	183	33	-	2468	1541
	1972	3851	167	107	186	34	-	4038	1451
Near East	1970	182	360	7	187	-	13	19	461
	1971	192	343	9	217	-	10	19	519
	1972	186	347	10	235	-	10	20	508
Far East (incl. People's Rep. of China)	1970	4435	3311	4091	6173	1871	27	12804	11414
	1971	3958	3411	4180	5787	1871	27	12895	10021
	1972	3908	3510	4331	6530	1548	27	12740	8495
Africa	1970	1320	373	381	358	64	1096	18	3950
	1971	1235	372	386	311	71	1078	14	4965
	1972	1237	428	392	332	66	1081	25	4534
Oceania	1970	1	-	73	-	-	1	3	43
	1971	4	-	70	-	-	2	9	33
	1972	2	-	70	-	-	2	25	28
World	1970	11534	5121	10473	7067	1968	1161	46474	17623
	1971	10851	5143	10360	6640	1975	1143	48410	18466
	1972	11010	5286	10731	7415	1648	1146	52712	16532

*Provided by courtesy of Food Policy and Nutrition Division, FAO.

TABLE II. AVAILABILITY OF SELECTED FOOD LEGUMES*

(Grams per caput per day)

Country	Chick peas	Cow peas	Dry beans	Broad beans	Dry peas	Pigeon peas	Soybeans	Ground-nuts	Unspecified	Total
AFRICA										
Algeria	2.6		0.7	3.6	0.7				3.3	10.9
Angola			20.0					3.9		23.9
Burundi			105.8		27.6			3.1		136.5
Cameroon			10.0					29.3	10.9	50.2
Central Africa Rep.								27.0	7.0	34.0
Chad								26.8	53.3	80.1
Congo (Braz.)								17.8	3.0	20.8
Dahomey			16.6					15.4	6.2	38.2
Egypt	0.8	0.6	0.8	8.6	0.1			3.5	8.2	22.6
Ethiopia	16.7		5.4	8.7	11.1			0.7	11.5	54.3
Gabon									0.8	0.8
Gambia								13.9	7.8	21.7
Ghana								6.4	2.7	9.1
Guinea								10.1	17.2	27.3
Ivory Coast			2.6					15.7	8.0	26.3
Kenya								0.8	64.9	65.7
Liberia								5.1		5.1
Libya	2.9			1.7	1.0			8.8	1.8	16.2
Madagascar		8.1	7.7	1.8				4.5	4.1	26.2
Malawi		4.2	4.2			3.5		12.5	0.7	25.1
Mali		5.5						15.3	6.7	27.5
Mauritania	23.7							0.9		24.6
Mauritius			0.7					2.8	24.5	28.0
Morocco	3.3		1.9	5.1	2.6			0.2	1.3	14.4
Mozambique									19.7	19.7
Niger								10.9	39.0	49.9
Nigeria							0.2	6.5	28.4	35.1
Rhodesia (S.)			7.1					20.0	4.1	31.2
Rwanda			101.3		33.8			7.0		142.1
Senegal		11.3						21.7	0.8	33.8
Sierra Leone				23.9	1.2			16.2		41.3
Somalia								2.2	12.1	14.3
Southern Africa								2.3	11.5	13.8
Sudan			2.0	1.8				1.2	11.3	16.0
Tanzania							0.5	1.1	32.6	34.2
Togo	20.1							11.7	14.5	46.3
Tunisia	4.7		0.6	6.6					0.8	12.7
Uganda	0.7	7.0	33.7		1.8	5.0	0.2	25.8		74.2
Upper Volta								19.8	55.3	75.1
Zaire			13.1				0.4	16.9	1.1	31.5
Zambia								20.7	45.5	66.2
AVERAGE**	1.8	0.6	5.2	2.2	1.6	0.2	0.1	7.0	15.5	34.3

(continued)

*Provided courtesy of the Food Policy and Nutrition Division, FAO.

Country	Chick peas	Cow peas	Dry beans	Broad beans	Dry peas	Pigeon peas	Soybeans	Ground-nuts	Unspecified	Total
ASIA AND FAR EAST										
Afghanistan									8.0	8.0
Burma	2.9	0.4	6.1		0.7	1.6		5.0		16.7
Cambodia			7.6				0.6	3.9		12.1
Ceylon	2.9	0.5			5.9			1.0	11.1	21.4
China (Taiwan)			7.6				58.5	8.3		74.4
India	20.4		8.1		3.8	8.2		1.6	9.3	50.4
Indonesia							7.6	10.6	11.6	29.8
Iran									10.0	10.0
Iraq			3.0	4.7	7.7					15.4
Israel								6.3	9.6	15.9
Japan							76.5		14.3	90.8
Jordan	6.1		5.7						11.6	23.4
Korea (S.)			1.5		0.1		13.7	0.4	0.4	16.1
Korea (N.)									39.2	39.2
Laos								0.7	10.8	11.5
Lebanon								2.6	20.7	23.3
Malaysia							5.5	1.0	8.9	15.4
Nepal									11.6	11.6
Philippines			0.6				0.5	1.1	2.6	4.8
Saudi Arabia	1.2		1.2	3.0				0.6	1.2	7.2
Syria				5.2				1.6	12.1	18.9
Thailand				0.9			1.5	3.9	6.6	12.9
Turkey	5.5		10.7	2.6	0.4			1.6	7.2	28.0
Vietnam (N.)			2.1				1.2	1.4	4.2	8.9
Vietnam (S.)			2.4				0.8	1.5	4.2	8.9
Yemen Arab Rep.									20.4	20.4
Yemen People's Rep.								0.3	10.5	10.8
AVERAGE	10.0	-	4.7	0.1	2.0	4.0	9.5	2.5	9.3	42.0
EUROPE										
Albania									25.0	25.0
Austria							0.4		2.4	2.8
Belgium-Lux.									7.2	7.2
Bulgaria									17.0	17.0
Cyprus									30.9	30.9
Czechoslovakia									3.9	3.9
Denmark									1.1	1.1
Finland									3.1	3.1
France									8.6	8.6
Germany (W.)									3.6	3.6
Germany (E.)									3.9	3.9
Greece									30.1	30.1
Hungary									23.8	23.8
Iceland									4.3	4.3

(continued)

Country	Chick peas	Cow peas	Dry beans	Broad beans	Dry peas	Pigeon peas	Soybeans	Ground-nuts	Unspecified	Total
Ireland									7.0	7.0
Italy									16.2	16.2
Malta									87.7	87.7
Netherlands									5.7	5.7
Norway									5.1	5.1
Poland									9.0	9.0
Portugal									19.4	19.4
Romania									23.2	23.2
Spain									20.2	20.2
Sweden									3.9	3.9
Switzerland								1.8	2.7	4.5
United Kingdom								1.2	8.8	10.0
Yugoslavia									24.6	24.6
AVERAGE								-	11.3	11.3
LATIN AMERICA										
Argentina	0.6		2.0		2.4				0.8	5.8
Bolivia			0.6	4.4	0.6			5.7		11.3
Brazil			1.7		0.2		3.2	12.8	0.1	18.0
Chile	0.9		13.2		1.9				0.3	16.3
Colombia			5.3		3.3			0.2	3.3	12.1
Costa Rica			29.6							29.6
Cuba			7.9					5.7	22.2	35.8
Dominican Rep.			26.5			14.9				41.4
Ecuador			13.1	9.9	8.5			1.6	3.1	36.2
El Salvador			28.1					0.3		28.4
Guatemala			28.6					0.3		28.9
Guyana									14.9	14.9
Haiti			24.3			1.9		1.7	21.2	49.1
Honduras			35.4							35.4
Jamaica									7.6	7.6
Mexico	6.8		48.9	2.2	0.3		0.8	2.8	0.3	64.1
Nicaragua			59.3							59.3
Panama			16.5		2.6			0.2	3.7	23.0
Paraguay			25.6	4.0	2.7			8.1		40.4
Peru	0.6		10.8	6.1	6.3			0.8	2.9	27.4
Puerto Rico									35.4	35.4
Trinidad & Tobago								3.2	28.1	31.3
Uruguay			3.0	1.0	3.0					7.0
Venezuela	0.6		17.3		4.3	1.6		0.7	0.5	25.0
AVERAGE	1.3	-	15.0	1.0	1.4	0.3	1.2	5.4	2.3	27.9

(continued)

Country	Chick peas	Cow peas	Dry beans	Broad beans	Dry peas	Pigeon peas	Soybeans	Ground-nuts	Unspecified	Total
NORTH AMERICA										
Canada			4.2		1.8			4.2		10.2
United States			8.5		0.6			6.8	0.2	16.1
AVERAGE			8.1		0.7			6.5	0.2	15.5
OCEANIA										
Australia								2.9	4.8	7.7
New Zealand									3.9	3.9
AVERAGE								2.3	4.6	6.9
China (Mainland)			3.9	8.4	6.7		18.4	1.5		38.9
USSR									12.3	12.3

Source: Food Balance Sheets 1964-1966 FAO, Rome, 1971.

TABLE III. DEMAND PROJECTIONS FOR BEANS, PEAS, LENTILS, CHICK PEAS AND SIMILAR DRY LEGUMINOUS CROPS*

(Thousands of tons)

Country	1965	1970	1975T	1980T	1975H	1980H
AFRICA						
Algeria	47	57	68	82	70	86
Angola	38	42	46	52	47	53
Burundi	153	171	191	214	192	218

*Provided courtesy of the Food Policy and Nutrition Division, FAO.

Note: For high-income countries, one growth rate in Gross Domestic Product (GDP) and the associated Private Consumption Expenditure (PCE) was used to make demand projections at constant prices. For developing countries, two alternative growth rates were applied to demand. The first, the "Trend" (T) alternative, represents the FAO Secretariat interpretation of representative past trends. The other is a "High" (H) alternative based on targets established by the UN and its Regional Commissions for the Second UN Development Decade.

Country	1965	1970	1975T	1980T	1975H	1980H
Cameroon	40	46	53	63	54	64
Central African Rep.	3	4	4	5	4	5
Chad	64	68	74	82	76	85
Congo (Brazzaville)	1	1	1	1	1	1
Dahomey	16	18	21	25	21	25
Egypt, Arab Republic of	205	225	269	317	270	325
Ethiopia	444	497	572	660	597	711
Gabon	0	0	0	0	0	0
Gambia	1	1	1	1	1	1
Ghana	42	47	55	65	55	65
Guinea	22	23	26	30	27	33
Ivory Coast	16	20	24	30	25	32
Kenya	222	270	329	403	336	420
Libya	4	7	10	12	11	14
Madagascar	48	55	62	71	62	72
Malawi	18	22	26	31	26	32
Mali	20	22	25	28	25	29
Mauritania	9	11	12	14	12	15
Mauritius	7	8	9	10	9	10
Morocco	70	83	97	114	97	116
Mozambique	50	58	68	79	69	81
Niger	50	58	67	79	69	81
Nigeria	606	660	806	973	808	1016
Rhodesia (S.)	19	23	27	32	27	33
Rwanda	153	183	214	252	215	258
Senegal	15	16	18	20	18	20
Sierra Leone	22	24	27	30	27	30
Somalia	11	13	15	17	15	19
Southern Africa	85	99	115	134	115	134
Sudan	74	86	102	124	102	128
Tanzania	139	169	200	237	203	251
Togo	21	24	28	33	29	34
Tunisia	21	23	27	31	28	34
Uganda	133	154	182	215	183	227
Upper Volta	95	104	118	134	118	136
Zaire	81	92	108	128	112	134
Zambia	62	78	95	116	100	128
TOTAL	3130	3462	4192	4944	4235	5155
ASIA AND NEAR EAST						
Afghanistan	46	53	61	71	63	77
Burma	105	118	135	154	136	160
Ceylon	83	102	120	143	121	146
China (Taiwan)	36	44	55	67	55	69
India	8492	9957	11638	13705	11926	14384
Indonesia	446	512	587	681	594	698
Iran	91	117	149	87	149	189
Iraq	46	57	70	13	70	91

(continued)

Country	1965	1970	1975T	1980T	1975H	1980H
Israel	9	10	11	13	11	13
Japan	449	475	505	533	505	533
Jordan	16	20	24	28	24	30
Korea (S.)	20	26	33	40	33	40
Korea (N.)	173	203	237	276	240	284
Laos	10	12	14	16	14	16
Lebanon	17	21	25	29	25	31
Malaysia	28	33	38	45	39	46
Nepal	43	47	52	58	52	60
Philippines	36	43	52	63	53	65
Saudi Arabia	11	15	18	22	20	25
Syria	33	40	48	58	48	58
Thailand	84	102	124	149	127	156
Turkey	297	368	445	535	450	545
Vietnam (N.)	42	48	57	67	60	74
Vietnam (S.)	39	44	51	59	51	60
Yemen Arab Republic	37	42	47	54	49	58
Yemen People's Republic	4	4	5	5	5	6
TOTAL	10693	12113	14601	17147	14920	17914
EUROPE						
Albania	17	21	25	29	25	29
Austria	6	6	7	7	7	7
Belgium-Lux.	26	27	27	28	27	28
Bulgaria	51	53	55	57	55	57
Cyprus	7	7	8	8	8	8
Czechoslovakia	20	22	23	24	23	24
Denmark	2	2	2	2	2	2
Finland	5	5	5	5	5	5
France	154	156	159	162	159	162
Germany (E.)	24	26	28	30	28	30
Germany (W.)	77	77	76	75	76	75
Greece	93	98	101	104	101	104
Hungary	88	101	113	125	113	125
Iceland	0	0	0	0	0	0
Ireland	7	11	12	13	12	13
Italy	309	313	318	323	318	323
Malta	10	10	9	9	9	9
Netherlands	26	28	29	31	29	31
Norway	7	7	8	8	8	8
Poland	104	117	130	146	130	146
Portugal	54	59	64	70	64	70
Romania	161	173	187	201	187	201
Spain	235	260	284	311	284	311
Sweden	11	8	8	9	8	9
Switzerland	6	6	7	7	7	7
United Kingdom	178	186	196	208	196	208
Yugoslavia	175	185	195	205	195	205
TOTAL	1853	1964	2076	2197	2076	2197

(continued)

Country	1965	1970	1975T	1980T	1975H	1980H
LATIN AMERICA						
Argentina	49	54	58	63	58	63
Bolivia	9	11	13	16	13	16
Brazil	1993	2309	2664	3074	2664	3074
Chile	52	61	70	80	70	82
Colombia	79	97	118	143	119	147
Costa Rica	16	24	30	37	30	38
Cuba	84	92	102	113	104	118
Dominican Republic	55	68	83	100	83	102
Ecuador	66	81	99	120	99	124
El Salvador	30	27	27	49	37	51
Guatemala	48	54	71	92	72	96
Guyana	4	4	5	6	5	6
Haiti	76	84	95	108	96	114
Honduras	28	38	48	59	48	61
Jamaica	5	6	6	7	6	7
Mexico	913	1049	1209	1393	1203	1378
Nicaragua	38	49	58	70	59	71
Panama	10	13	16	20	16	20
Paraguay	24	29	34	41	34	41
Peru	114	130	161	200	162	203
Puerto Rico	34	38	44	49	44	50
Trinidad and Tobago	10	11	12	14	12	14
Uruguay	7	7	8	9	8	9
Venezuela	85	103	125	151	126	156
TOTAL	3729	4439	5156	6014	5172	6041
NORTH AMERICA						
Canada	41	43	44	45	44	45
United States	664	615	640	665	640	665
TOTAL	705	658	684	710	684	710
OCEANIA						
Australia	20	23	26	30	26	30
New Zealand	4	4	5	5	5	5
TOTAL	24	27	31	35	31	35
China (Mainland)	5307	5965	6729	7586	6822	7793
USSR	1031	1116	1200	1295	1200	1295
WORLD TOTAL	26472	29739	34669	39928	35140	41140

Source: FAO Agricultural Commodities Projection, FAO, Rome, 1971.

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SYMPOSIUM ON LEGUMES AND GREEN LEAFY VEGETABLES IN THE NUTRITION OF THE INFANT AND YOUNG CHILD

As long as breast feeding continues adequately for four to six months after birth, an infant is reasonably well protected, but the moment milk becomes insufficient, the infant enters a dangerous period of its life. The traditional society has resources in the form of food legumes, oilseeds and edible green leafy vegetables which if properly prepared, cooked and used along with the staple of the region will go a long way toward providing nutritious weaning foods for young children. However, present indications are that these foodstuffs are rarely introduced into young children's diets in the developing countries.

The PAG ad hoc Working Group on Feeding the Preschool Child, which met in Geneva, 11-13 December 1972 (see PAG Bulletin III, No. 1, 1973), devoted some time to considering this problem with special reference to the amounts of food legumes and green leafy vegetables that can be safely fed, the methods of preparation, acceptability, and other problems in child feeding. Practical steps were considered to overcome some of the difficulties in making legumes and edible green leafy vegetables accepted as part of the regular diet of young children in developing countries.

The meeting had available to it for discussion three primary papers and several short notes describing experience in the use of legumes and/or green leafy vegetables in young child feeding in different parts of the world. These articles and notes have been edited and published in the following pages as a symposium on "Legumes and Green Leafy Vegetables in the Nutrition of the Infant and Young Child". The symposium begins with a section of the report of the ad hoc Working Group, dealing with this subject, as endorsed by the PAG.

LEGUMES AND GREEN LEAFY VEGETABLES IN CHILD FEEDING*

THE USE OF LEGUMES IN YOUNG CHILD FEEDING

Many different legumes are found throughout the world, with certain species dominant in particular areas and each species represented by a large number of varieties (1).

Nutritional value

Nutritionally, legumes are recognized as being the highest plant sources of protein, up to 25% in dry grains with soy having up to 40%. The limiting essential amino acid is methionine. However, as has been discovered pragmatically in many communities over the centuries, appropriate cereal-legume mixtures can supply the complete range of essential amino acids. Examples include the *tortillas* (corn) and *frijoles* (beans) of Mexico, the rice and *dhal* (legume) of India, and the rice and soy preparations of China.

The nutritional value of legumes is suggested by the fact that it is possible for vegans** apart from a B_{12} deficiency in some, to maintain good health on a carefully-selected vegetarian diet (2) and by the fact that severe protein-calorie malnutrition can be cured by an appropriate mixture of cereal and soy,

*As accepted by the PAG at its 21st Meeting, 4 June 1973, for release.

**Complete vegetarians, eating no foods of animal origin, including milk.

peanut or other legume protein without any source of animal protein. Unfortunately there is a wide variation in nutritional composition (including biological value), flavor, cooking properties, etc., not only between different legumes but also between different strains of a single variety.

Fresh legumes are dietary sources of thiamine, niacin, riboflavin, calcium, folate, iron and vitamin C. The dry grain legumes, however, show little or no ascorbic acid, while sprouting legumes have an increased content of thiamine and riboflavin, as well as ascorbic acid. Legumes contain approximately 60% carbohydrates, mainly starch which is well absorbed and metabolized, and also a variety of oligosaccharides.

The soybean is in a special category and much is known about its use in traditional preparations, its processing by modern technology and its therapeutic effectiveness in the management of protein-calorie malnutrition in young children.

Processed, vitamin-enriched "milks" prepared from soy have been used successfully as the sole food for young babies under six months of age, including allergic infants without infections, diarrhea, etc. (3). Similarly, a groundnut flour "milk" has been used as a partial replacement for cow's milk feeds in infants between 2-13 months (4). However, legumes should be considered mainly for use as weaning foods or as components of weaning mixtures for feeding infants and children from 4-6 months onward.

Problems in the use of legumes in the home

Detailed quantitative food consumption data are not widely available for very young age groups in general. In developing countries legumes are rarely introduced into children's diets early in life and do not play their full potential role in infant feeding. There are a few problems encountered in the regular use of legumes, separately or mixed with other foods, for feeding young children at home.

Cultural factors. In all cultures, the different ways in which legumes are classified can be extremely important to practical infant feeding. In some areas, legumes have a low status, while in others, such as India and some other Asian countries, the opposite is often the case. Information on this point on a world-wide basis would be of great help in practical infant and child feeding.

Toxicity. A considerable number of toxins have been described as occurring in different types of legumes. Many of these are not of real importance from the practical point of view in young child feeding as, in general, legume toxins can be more or less destroyed through adequate prior soaking and subsequent cooking. However, problems still exist with regard to the toxin in broad beans (*Vicia faba*), related to the disease favism, which is common in some Mediterranean communities.

Digestibility. Of more importance is the well-recognized lack of digestibility of certain legumes. This property seems to vary from variety to variety within each species and is related to two main factors: the method of home processing and inherent characteristics.

The preparation of legumes can be related to the subsequent digestibility at various stages, including milling, husking, etc. The quantity eaten is also relevant, as is the condition of the digestive tract itself.

Inherent properties of legumes related to their digestibility can be physical and/or biochemical. Thus, inherent physical properties include the ease of milling, especially in relation to the adherence of the gums between the husk and cotyledons which determines how firmly fixed the husk is to the endosperm.

One factor related to indigestibility, but also a deterrent in its own right to maternal acceptance of legumes for young child feeding, is the production of intestinal gas or flatulence. Mothers complain that the amount of certain legumes they can feed the young child is limited by the abdominal distension and discomfort induced and by loose, foul-smelling stools. Very little is known about the validity or basis for these complaints and they should be seriously investigated.

Practical approaches

Selection. The legumes used in young child feeding will obviously depend initially on those available in the particular area. Selection will be based on cultural preferences, knowledge of nutritional composition (both protein and other nutrients), culinary attributes (including the cooking time), and apparent digestibility.

On a world basis, in the past, most attention has been paid to and most publications have been concerned with the use of three legumes in weaning foods: the chick pea (*Cicer arietinum*), groundnut and soybean. However, attention has also been given to the kidney bean (*Phaseolus vulgaris*) in Latin America and Central Africa and the broad bean (*Vicia faba*) in Mediterranean countries. Other legumes in other regions, such as lentils (*Lens esculenta*) or cow peas (*Vigna sinensis*), should also be considered.

Quantity. Defining the tolerable amount of legume that can be fed to young children is a basic difficulty. This is particularly difficult to determine since the definition of "optimal" has to take into account a number of different constraints. These include the nutritional purpose of the legume supplementation in relation to the other foods in the mixture fed at one time and in the total daily diet, the actual and culturally- acceptable concepts as regards digestibility, and the type and preparation of the particular legume. Evidence suggests that young children of about one year of age can tolerate from 25-60 grams/day (5) of well-cooked chick peas, while 50-80 grams of groundnut flour have been used in Senegal (4). In all cases, although difficult to prove, it seems likely that "intestinal adaptability" to the newly-introduced food had taken place. It is probably wisest to introduce legumes in a relatively dilute way to start with, say a 1:4 mixture with the staple, and gradually increase the content of legume as the child becomes adapted or accustomed to the new food. Tolerance to some legumes, especially the kidney bean, also appears to increase with age.

Preparation. Legumes may be consumed in a variety of forms, including various green legumes eaten in the pod (an interesting combination in natural circumstances of a legume and a dark green leafy vegetable). If acceptable in the community, the possibility of using germinated or sprouted legumes needs consideration. Fermented legume preparations such as have been developed with soy in China and Japan can make the incorporation of legumes into domestic home-made weaning mixtures* for young children easier (6, 7). In some communities legumes may also be available for sale in forms which seem to be particularly suitable for use in infant foods - flours, split legumes (such as the *dhals* of India) and toasted or roasted legumes (*channa* of India).

If dry whole grains are used the preparation and cooking must aim at the production of the smoothest paste possible. Skins must be removed, usually by prior soaking or following boiling. If cooking is done by boiling, it should be followed by mashing or sieving. The length of time required for the cooking of a legume and the amount of fuel needed are important factors which will determine the attitude of the mother towards its use in child feeding.

The method of preparation and cooking must also be based on local practices, as with the plantain-leaf *ettu* packets used in Buganda and the fermented soybean preparations such as *miso* and *tempeh* which are traditional in countries of East Asia. Their use in child weaning should be expanded, especially because of their easy digestibility.

There is undoubtedly a great need for applied, domestic or "grass-roots" food technology with regard to the home processing and cooking of legumes in such a way that they will be maximally digestible and will cause the least expenditure for fuel and the least destruction of nutrients.

Recommendations

Further studies should be undertaken on the

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*Some authors use the term "multimixes" to describe these home-made weaning mixtures which represent simple mixtures of cooked cereal, a legume and a green leafy vegetable in appropriate quantities.

identification, selection and genetic improvement of legumes, especially the major varieties. A periodic review of the activities of the international and national centers of research should be made and the results widely publicized. Further studies are needed on nutrient content, especially methionine; digestibility, including the flatulence factor; cooking properties; organoleptic properties; yield; and disease resistance of legumes commonly used in the various countries. Investigations on the metabolic tolerance levels of well- and malnourished young children to legumes and legume-based "milks" are required. Special attention should be paid to studies on flatus production and digestibility at different ages.

Research is needed on the toxic factors present, especially in broad beans, and how to eliminate these and on levels of flatus factors such as oligosaccharides, etc.

Research is also needed on village-level food technology for the preparation of legumes, including optimum practical design of domestic utensils.

Field studies are required to determine the method and level of incorporation of legumes into home-made weaning mixtures within the framework of the traditional methods.

In drawing up food and nutrition policy in developing countries, emphasis should be given to increased and more efficient production of legumes at low cost, to special marketing incentives and to storage of surpluses.

THE USE OF DARK GREEN LEAFY VEGETABLES IN YOUNG CHILD FEEDING

Introduction

An immense variety of dark green leafy vegetables exists, many of which are known to be edible. In general, edible green leafy vegetables appear to be underutilized throughout the world and may in some areas even be diminishing in use. They are inexpensive, high-yielding, already part of the local diet and often easily available, but they frequently have a low status. Even among nutritionists the importance of edible leaves in human diets seems inadequately stressed. Among edible green leaves the darker leaves are nutritionally more desirable than the pale green ones; however, the young tender leaves are more digestible and contain less fibrous material.

Nutritional value

Nutritionally, many edible leafy vegetables are excellent sources of carotene, folate, niacin, iron, vitamin C and calcium. They are of special importance in the prevention of avitaminosis A, a major cause of blindness in young children particularly in some Asian countries. Leafy vegetables are best considered as vitamin and mineral supplements and as a minor source of protein when used in home-made weaning mixtures. They contain 3 to 5% protein in the fresh state and between 20 to 49% when dried. Moreover, the protein is usually high in lysine and tryptophan, so that they are valuable in supplementing the amino acid deficiencies of cereals and improving the protein quality of cereal-based diets in much the same way as do legumes. They may be eaten as fresh leaves, particularly the young leaves, or in a powdered form obtained by sun-drying and/or smoking.

Some common edible leaves

The edible green leafy vegetables range through such plants as cassava, sweet potato, a variety of different types of wild amaranthus, colocasia, and many others, including wild species.

Extensive work has been done on cassava leaves, which are stated to contain between 30 to 40% of protein when dried, with 4% in fresh young leaves (8). The leaves are plucked in such a way that some are left intact to permit the tuber to continue to grow. The simplest preparation is by shredding and boiling for some minutes (up to 15 minutes for the bitter variety) which vaporizes much of the hydrocyanic acid of the cyanogenic glucosides; the rest is removed by discarding the water.

Problems in weaning mixtures

Leafy vegetables are not usually considered individually in relation to the diet of young

infants (0-6 months), but rather in weaning mixtures. As in the case of legumes their use is not widespread for various reasons. Some of these are as follows:

Cultural factors. Leaves are not often considered for use in the food of young children during the transitional period of six months to two years. In some communities, the dark color of the leaf may lead the mother to consider the preparation indigestible by her young child. However, in many parts of the world, leafy vegetables figure prominently in the sauce eaten with the staple by older members of the family.

Digestibility. This seems to be related to the amount of crude fiber present, so that young leaves with the fiber removed are the most digestible. Also, certain thicker leaves may be less digestible because of mucilages and gums that are present.

Toxicity. The presence of pharmacologically-active substances in some leaves is suggested by clinically-recognized side effects or by chemical analyses (as with the cyanogenic glucosides in cassava leaves). Systematic studies are required to recognize such effects and identify the factors responsible.

The problem of nitrate toxicity does not seem relevant to the use of leafy vegetables in home-made weaning preparations in developing countries. This condition is of consequence in young babies of up to three months who are fed large quantities of spinach grown in areas with soils containing high nitrate levels (natural and from chemical fertilizer).

Practical approaches

Selection. It is obviously important to know the range of different species available in the particular area during different seasons of the year, their nutrient value and possible toxicity, and the likelihood of their cultural acceptability by the mothers concerned. Such calendars for green leafy vegetables will be highly useful in practical programs for educating mothers in their use for feeding young children.

Quantity. The basic question is the quantity of the leafy vegetable which may be fed to the young child in a home-made weaning mixture with benefit and with tolerance. Usually the purpose of the addition of the leafy vegetable will be to increase the intake of carotene, folate and/or iron to levels that will prevent nutritional deficiency.

Thus, in the prevention of avitaminosis A, it has been shown in southern India that children between 2-5 years of age may eat, digest and benefit from 30 grams of amaranthus each day which supplies them with 2,500 to 3,750 international units of beta-carotene. In a 3-month study, such an intake raised the serum vitamin A level from about 20mcg to about 30mcg (9, 10). At the end of this period, when the amaranthus feeding was stopped, the serum levels remained high for a period of 4-5 months thereafter. In some cases Bitot's spots disappeared.

Evidence indicates, therefore, that young preschool children can tolerate quantities of one leafy vegetable, amaranthus, up to 30 to 50 grams a day. Information does not seem to be available on feeding trials before two years of age or with other edible leafy vegetables.

Preparation. Young leaves are preferred which can be shredded and the fiber present discarded. They can be added to the cereal/legume cooking pot near the end of the cooking, so that the leaves are exposed to heat for a relatively short period with minimal destruction of ascorbic acid and folate.

Leaf protein concentrate. Technological and nutritional investigations are in progress in various countries to examine the prospects of preparing and using leaf protein concentrate as a source of protein in the diet. The concentrate, as its name implies, can be expected to provide only the protein and not the vitamins and minerals which consumption of fresh leafy vegetables would offer.

Recommendations

The nutritional importance of edible green leafy vegetables in general diets should be constantly emphasized, with special relation

to home-made weaning mixtures, and regular consumption should be encouraged by adopting intensive educational measures.

All available information on nutritional quality and dietary uses of familiar and not-so-familiar edible green leafy vegetables should be collected and made available to those engaged in field nutrition work.

Research is needed into the metabolic response (regarding availability and utilization of vitamins and minerals) of young children, including infants, to different amounts of various species of edible green leafy vegetables

Systematic study of the nutritional composition, especially carotene and available folate, and toxic factors should be part of the work of well-equipped centers for research into food vegetables. Studies on yield, disease resistance, etc., are also important.

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USE OF LEGUMES AND GREEN LEAFY VEGETABLES IN THE FEEDING OF CHILDREN : A REVIEW OF EXPERIENCE

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LEGUMES

Introduction

Legumes, also known as pulses, constitute an article of food all over the world. However, their use is particularly widespread in the tropics and the subtropics, and they are an important source of protein in traditional diets. By virtue of being the richest sources of protein among vegetable foods, they are consumed in relatively large amounts

where foods of animal origin are expensive or in short supply. Although there are over 13, 000 species of the family "leguminosae", the following 18 legumes are extensively cultivated today for purposes of human consumption: Arachis hypogaea (groundnut), Cajanus cajan (pigeon pea), Cicer arietinum (chick pea), Dolichos uniflorus (horse gram), Glycine max (soybean), Lablab niger (hyacinth bean), Lathyrus sativus (khesari dhal), Lens esculenta (lentil), Parkia biglobosa (African locust bean), Phaseolus mungo (black gram), Phaseolus vulgaris (kidney bean), Pisum sativum (pea), Pisum arvense (field pea), Vicia faba (broad bean), Vigna unguiculata (cow pea), and Voandzeia subterranea (bambara). Of these, groundnut and soybean are cultivated primarily for their oil content.

Certain types of legumes are preferentially cultivated and consumed in certain parts of the world and there are wide variations in the amount of legumes eaten, depending upon the agricultural conditions, whether rural or urban, and income levels. There appears to be an inverse relationship between the availability of legumes and animal foods. In Asian countries like India and Japan, the consumption of legumes tends to increase with increasing income, while in countries like the U. S. A. and Italy, the opposite trend has been noted.

Chemical composition and nutritive value

The chemical composition and nutritive value of the more commonly used legumes have been determined by many workers. In general, legumes are known to contain 18 to 25% protein, except groundnut and soybean, which have much more. Legumes are also generally fair sources of thiamine, riboflavin, niacin and iron, but relatively poor sources of calcium. They are poor sources of fat.

Most legumes, when properly cooked, have a digestibility exceeding 85 to 90%. Many legumes contain trypsin inhibitors, which are destroyed either by simple heating or by more elaborate heat treatment. On theoretical grounds, therefore, the presence of such inhibitors may be expected to adversely affect the growth-promoting activity of the legume, if eaten raw. The observation that heating improves the biological value of many legumes (in laboratory animals) indicates that the presence of these trypsin inhibitors does, to a certain extent, modify the nutritional quality. Although the presence of such inhibitors provides the most likely explanation for the observation that heating increases the in vitro digestibility of some legume proteins, it is obviously not the sole explanation, because heating or autoclaving is not always associated with improvement in nutritive value of all legumes. Also, the presence or absence of improvement is not associated with presence or absence of trypsin inhibitors. Simple germination is also known to improve the biological value of some legumes by as much as 20%, though it is not associated with alterations in the content of trypsin inhibitors. Because of these considerations, the presence of trypsin inhibitors in legumes need not be a major concern regarding nutritional quality, except perhaps in the soybean.

In addition to trypsin inhibitors, the presence of a variety of toxic substances like hemagglutinins, saponins, alkaloids, cyanogenic glucosides and goiterogenic factors has been reported in a number of legumes (1). (See Table I). But, on the whole, there is little evidence to show that the presence of such factors is associated with frequent or serious untoward developments. However, consumption of raw scarlet runner beans (Phaseolus coccineus), kidney beans and soybeans has been found to produce nausea, vomiting and diarrhea, an observation believed to be due to the presence of trypsin inhibitors and hemagglutinins. Such symptoms do not occur with cooked beans. Similarly, some infants fed with soymilk have developed goiter. Since the goiterogens have also been found to be heat-labile, it is possible that the infrequent cases of goiter may have been due to inadequately processed soybean, an observation that emphasized the need for proper heat-processing of this particular bean. Small lymphocytes treated with phytohemagglutinins undergo transformation and such transformed lymphocytes have an appearance very similar to cells of a rare malignant condition in Africa known as Burkitt's lymphoma. Although a number of factors are believed to be etiologically related to Burkitt's

TABLE I. THE EFFECT OF HEAT ON THE NUTRITIVE VALUE OF LEGUMES AND THE PRESENCE OR ABSENCE OF TOXIC COMPONENTS

Botanical name	Common name	Nutritive value*	Trypsin inhibitor	Hemagglutinin	Other
Arachis hypogaea	peanut	+	+	+	goiterogen
Cajanus indicus (cajans)	red gram	+	+	-	
Dolichos lablab	horse gram	+	+	+	
Faba vulgaris	double bean	+	+	?	
Glycine max	soybean	+	+	+	goiterogenic factor, saponin, anticoagulant, diuretic principle, toxic history
Lathyrus sativus	khesari dhal	+	?	?	human lathyrism
Lens esculenta	lentil	+	+	+	
Phaseolus aureus (radiatus)	mung bean	+	+	+	
Phaseolus mungo	black gram	+	+	?	
Phaseolus vulgaris	navy bean, kidney bean, pinto bean, French bean, black bean, white bean	+	+	+	goiterogenic factor
Pisum sativum	field or garden pea	+	-	+	goiterogenic factor
Vicia faba	fava bean	+	-	+	favism, cyanogenic glucoside

* + indicates improvement after heating, while - indicates no change. Adopted from Liener (1).

lymphoma and a virus has recently been implicated, a contributory role of hemagglutinins ingested through the diet has been suggested (2). Though it is true that the consumption of beans is high in Africa, beans are consumed by many other population groups in many parts of the world at equally high levels, but Burkitt's lymphoma is extremely rare outside Africa.

Among other toxins in legumes, two are of some concern: a) the toxin present in Lathyrus sativus (khesari dhal), the consumption of which is associated with human neurolathyrism, a form of spastic paraplegia, and b) the toxin present in Vicia faba (broad bean), the consumption of which is associated with favism.

The toxic principle in Lathyrus sativus is not fully understood as yet, but is believed to be in some way related to the presence in the seed of an unusual amino acid, β-oxalyl-aminoalanine (BOAA) (3). This compound is water-soluble and can easily be removed by steeping the seeds in hot water and discarding the steep water or alternatively, by parboiling the seeds, a procedure that minimizes the loss of water-soluble nutrients which occurs in the first process.

Hemolytic anemia, which is a characteristic feature of favism, is sometimes seen in some Mediterranean countries, following the use of uncooked broad beans. Here too, simple heating of the beans renders the seeds safe

for consumption.

A problem of an entirely different nature is associated with the use of groundnuts, the problem of contamination with the fungus Aspergillus flavus, some strains of which elaborate a group of potent hepatotoxins called aflatoxins. While the implications of ingesting aflatoxins in man are not clear as yet, their hepatotoxic and carcinogenic properties in nonhuman primates (4) clearly underline the need for caution in the use of contaminated groundnuts for human feeding and the need for setting permissible levels for aflatoxin in foodstuffs. Apart from groundnuts, many other foods, including millets and cereals, have now been shown to be capable of becoming infected with A. flavus. That gossypol, the pigment toxin in cottonseed, and aflatoxin can act as cocarcinogens is also a matter of concern.

Protein quality

The biological value of various commonly-used legumes has been found to vary between 40 and 78, and the protein efficiency ratio between 0.7 and 2.1 (5). Not only are there variations between legume species, but also among members of the same species. This is as much due to differences in the details of experimental procedure as to the differences in chemical composition of different varieties of the same legume. Analysis of protein for its amino-acid make-up has shown that the sulfur-containing amino acid methionine and tryptophan are the limiting amino acids in that order. Legumes are relatively rich sources of lysine, which is the limiting amino acid in cereals and millets, and the judicious combination of cereals and legumes can, therefore, improve the amino acid balance of the diet as a whole.

It is obvious, therefore, that legumes possess great potentialities for augmenting human food supplies in general and particularly for providing protein, especially in developing areas of the world, as a supplementary source of protein where cereals and millets are the staples. The presence of various types of toxic substances is not a major drawback to their extensive and safe use, since suitable cooking and processing procedures can almost totally eliminate the toxins.

Quantity of legumes that can be used in human feeding

Infants below six months. In traditional infant feeding, legumes do not generally play any significant role, particularly during the first four to six months of life, when maternal milk is adequate to meet the nutrient needs of the growing infant. There have, however, been instances where legume-based milk substitutes have been used. Although no recommendations have been made so far regarding the amount of legumes that can safely be given to infants, it is possible from these investigations to indicate the amount of legumes that have actually been tolerated by young infants. Among legumes that have been used for the feeding of young infants are soybean and groundnut.

There are many references in the literature regarding the use of processed soybean as the sole source of protein in the feeding of young infants (6). All these reports indicate that their acceptability is good, that there were no undesirable side effects, and that the growth performance of infants fed these preparations was satisfactory. More recent studies in infants aged between 113 and 154 days, who were fed a soybean formulation (to which no amino acids were added, but vitamins were) alternately with human or cow's milk have shown that over a period of 36 to 72 days, the growth rate, nitrogen retention and nitrogen in serum during the feeding of the soy preparation were identical with those observed with human milk and cow's milk (7).

It has, however, been repeatedly emphasized that the problem of trypsin inhibitors in soybean needs to be carefully looked into, particularly in preparations meant for infants, since tryptic activity in intestinal secretions is very low in infants up to six months of age.

Spray-dried preparations containing groundnut protein in combination with milk solids and small amounts of enzymatically-treated wheat and barley have also been used in the feeding of young infants. These preparations contained 26% protein, 65% of which came from groundnut.

Infants below one month of age who received such a preparation were found to grow as well as those who were fed a conventional milk-based infant food. The net protein utilization (NPU) of the preparation was reported to be between 70 and 82% (8, 9).

Preparations of peanut flour alone in water with added sugar have also been used in infants between the ages of 2 and 13 months, as part replacement of milk feeds. Amounts up to 25 grams per feed were used. The acceptability was found to be good, though when continued beyond six weeks, infants were found to lose appetite and develop an elective anorexia to this food. When mixed with skim milk and millet flour, as much as 60-75 grams of peanut flour was accepted and consumed by some infants and the anorexia noted with peanut flour alone was not observed. Some infants consumed as much as 125-140 grams of peanut flour a day over a period of nearly 20 weeks. The digestive tolerance of both preparations was found to be good and weight gains were also satisfactory (10).

Peanut flour fortified with vitamins and minerals as the sole source of protein has been used in the feeding of premature infants and found to be well tolerated. The NPU of the food was found to be only 37, but at intakes of 5g protein/kg body weight, growth occurred satisfactorily. There were no problems connected with the feeding (11).

It would thus appear that at least these two legumes, both oilseeds, can be used for the satisfactory feeding of even very young infants. It would also appear that they can both be used as the sole source of protein. There have been few attempts so far to include other legumes in the feeding of infants below six months of age.

Infants of six to twelve months. A large number of weaning food mixtures for feeding older infants, containing various types of legumes and different amounts of legumes, have been developed by many workers all over the world and particularly in the developing countries. Their acceptability, tolerance and efficacy of promoting growth have been tested and found satisfactory. Most have been developed for commercial distribution. Some of them are indicated below:

1. Wheat flour, Bengal gram (chick pea), lentil, milk and sugar: Superamine, Algeria.
2. Wheat (7), soy or groundnut (1.5), Bengal gram (1.5): Balahar, India.
3. Groundnut, dried milk, wheat and barley: Lactone, India.
4. Groundnut (3), Bengal gram (1), dry milk (1): Multipurpose food, India.
5. Soy, sesame, groundnut, fat, sugar: Saridele, Indonesia.
6. Wheat (6), Bengal gram (3), milk (1): Laubina, Jordan.
7. Groundnut (3), dry milk (1): Arlac, Nigeria.
8. Millet (4), groundnut (2), dry milk (2), sugar (2): Ladylac, Senegal.

(Figures in brackets indicate the proportions used).

The inclusion of milk has always been found to improve the nutritional quality of these mixtures. The amount of legumes that have gone into these preparations has varied between 20 and 80%, either from a single source or from a combination of two legumes. It may be considered significant that only three legumes, soy, bengal gram and groundnut, repeat themselves in all these preparations.

Children of one to three years. All the preparations listed above, which have been used as weaning foods, have also been used as supplementary foods for older children. In many developing countries of the world, protein-calorie malnutrition (PCM) continues to be a major public health problem among preschool children and severe forms of the disease such as kwashiorkor and marasmus are frequantly encountered. Diets based upon dry milk protein have previously been employed for the successful treatment of such cases. Since milk is expensive and in short supply in many of the areas where PCM is widespread, the efficacy of diets based upon vegetable sources of protein, which are cheaper and more readily available, has been tested extensively during the last two decades by a

number of workers. Soybean, Bengal gram* and groundnut are the three legumes most frequently used, either singly or in combination with milk or vegetable foods like cereals, millets or other oilseeds (6, 12-16).

A common finding in most studies is that, judged from the clinical response, the various vegetable diets used were as good as diets based exclusively on milk, but judged from the biochemical response, chiefly the ability to promote regeneration of serum albumin, they were inferior to milk. This drawback has been shown to be overcome by either raising the level of protein intake or prolonging the period of treatment with vegetable protein diets (12). Another significant observation is that the nutritional quality of diets based on a combination of a legume (groundnut or Bengal gram) and milk, wherein the protein is derived in a proportion of 3:1, is as good as diets based upon milk protein alone (17, 18).

In one study, Bengal gram, germinated, dried, powdered and cooked, was fed to children suffering from kwashiorkor, and provided daily as much as 60g protein (300g of Bengal gram) for a period of 4 to 6 weeks. There were no problems of acceptability or tolerance (13). In another study, 300g of soybean, dehusked, soaked and cooked for ten hours and fed to children suffering from kwashiorkor, was well tolerated and brought about a satisfactory cure (14). A preparation made of 75 parts groundnut and 25 parts Bengal gram to provide 50g protein, given along with wheat bread which provided another 18g of protein, has been found effective in the treatment of kwashiorkor (12).

These data provide information on two important aspects of legume feeding:

1) That legumes are accepted, tolerated and utilized satisfactorily even by children who are acutely ill and who are severely malnourished. Their use in normal children and in children who are mildly or moderately undernourished, therefore, would raise no unsurmountable problems.

2) That there is perhaps virtually no limit to the amount of legumes that can be safely given to children provided they are suitably processed.

A long-term feeding trial extending over nearly one year, with the use of preparations containing milk, rice and legume protein has been done in India. Children between 1 and 5 years of age received a full daily quota of proteins and calories under controlled feeding conditions. Rice and vegetables formed the basal diet. One group of children received additional protein from two pulses, green gram (Phaseolus aureus) and red gram (Cajanus cajan), while another group received the same amount of protein from milk. Fifty per cent of total protein came from either legumes or milk. Acceptability and tolerance of both diets were good. The growth of children in the two groups was identical, suggesting that pulse proteins are satisfactory replacements for milk (19).

As mentioned earlier, the results of several studies indicate that relatively large amounts of legumes are accepted and tolerated by infants and young children, with satisfactory growth performance. Legumes are to be used primarily as supplementary sources of protein to balance the protein quality of the staple and to provide the requisite amounts of nonessential nitrogen. The optimal amounts will, therefore, depend upon factors such as availability and protein content of the habitual diet contributed by the staple cereal, wheat, rice, millets, etc. Legumes could be used safely in amounts to provide as much as 50 to 60% of total protein in the diet. Satisfactory improvement in nutritional quality of cereal-based diets has been achieved when legumes have been included so as to provide 30% of protein intake.

Some problems associated with the inclusion of legumes in the diets of infants and children

Toxic factors

a) Endogenous toxins. The presence of various types of toxic substances in legumes has already been discussed. As indicated earlier, these

*Chick pea (Cicer arietinum). Gram is the term used in India to denote the whole seed.

should not really pose a problem, since simple processing procedures like heating, boiling, toasting, puffing and autoclaving, which can be employed even at the household level, can render the toxins ineffective. It may also be possible to breed out these toxins from legumes. This procedure may, however, raise other problems related to agronomy, such as resistance to disease, pests, etc. The physiological significance of the presence of these substances from the point of view of the economy of the plant is not clear. At least in the case of cottonseed, it has been recently observed that glandless varieties bred to eliminate the presence of the toxic pigment gossypol, were more disease-prone and less pest-resistant than conventional varieties.

b) Exogenous toxins. The problem of fungal contamination of groundnut acquires special importance in view of the increasingly greater use of groundnut flour for feeding infants and children. Malnutrition is known to adversely modify the response to many toxins and the effects of aflatoxin have been demonstrated to be more severe in malnourished animals. Since most communities which are likely to use groundnut-containing foods are also likely to be undernourished, the question of quality control becomes an important one. Strains of groundnut which, though infected with *A. flavus*, do not elaborate the toxin, have been identified. The use of such varieties, coupled with improved harvesting and storage practices, may effectively control the problem.

Many of the weaning foods and supplementary foods which use groundnut or soy are likely to utilize the oilseed meals after the oil has been extracted. To obtain better quality meals and to get a preparation as low in fat as possible, solvent extraction procedures are being increasingly employed. This procedure is a potential health hazard, particularly in developing countries, if proper food-grade solvents are not used and care is not taken to ensure that solvent residues are removed. Acceptable solvents have recently been evaluated (20).

Flatulence. One of the problems associated with the ingestion of legumes is the formation of intestinal gas. The inclusion of beans in daily diets providing about 25% of calories has been found to produce a 4- to 10-fold increase in gas formation (21). There are wide variations in the flatus-producing capacity of legumes. Bengal gram, soybeans, lima beans and navy beans appear to be particularly active. Flatulence arising from the consumption of these legumes is, from the point of view of acceptability, an important aspect since many people associate flatus with poor digestibility and hesitate to include legumes in the diets of infants, young children and the sick.

The mechanism of increased flatus production is not known. Studies in man have shown that much of the gas formed is carbon dioxide. Studies in animals have shown that it is not due to the high fiber content, since ingestion of methylcellulose does not increase flatus. It does not appear to be due to intestinal microbial action, since the use of antibiotics does not always limit gas formation (22-24). Heated legumes always produce less gas than raw legumes, suggesting the presence of an active, heat-labile principle.

Though there have been many studies on the protein content and the nature of protein in legumes, there are relatively few studies on their carbohydrate makeup. It has been suggested on the basis of some studies that the nature of the carbohydrates in legumes may have a role in the differences seen between legumes in their capacity to produce gas. Studies on four commonly-used legumes in India, Bengal gram (*Cicer arietinum*), red gram (*Cajanus cajan*), black gram (*Phaseolus mungo*) and green gram (*Phaseolus aureus*), have shown that the rate of *in vitro* amylolysis, an index of digestibility of carbohydrates, in these four legumes was lowest in Bengal gram and highest in green gram, with the other two falling between. The rate of amylolysis is related to the amylose content. Whether the whole legume was used, cooked or raw, or whether the isolated carbohydrate was used, trends were similar (25). Of these four legumes Bengal gram has the greatest potential to produce gas.

The exact mechanism by which legumes promote gas formation needs to be investigated, since the acceptance of these foods in the diets

of young children will considerably improve if the factor(s) can be identified and simple methods for removal developed.

Cooking time. Many pulses and beans do not cook easily and must be cooked for much longer periods of time than cereals and millets. Though this may not be a crucial factor, it may nevertheless be desirable to develop simple methods to reduce cooking time. Cooking with papain has been reported to cut cooking time by nearly 50% (26). Other methods need to be developed.

Food beliefs and taboos. One of the most important factors which seriously limits the inclusion of legumes in diets is the belief held by many communities that they are hard to digest and should not, therefore, be given to infants and young children whose gastrointestinal system cannot tolerate them. There are also taboos regarding the use of legumes during sickness and during certain seasons of the year. Many pulses are believed to be "hot" foods and are thus to be avoided during summer months. Some pulses are believed to lead to suppuration if consumed by children who have been injured. Some of these beliefs, particularly those referring to the intestinal upsets following the use of improperly cooked preparations, are not without foundation, but the other beliefs are without scientific basis.

Educating the community regarding the true nutritive value of legumes, coupled with adequate demonstration of the proper methods of preparing them, are obviously essential to remedy the situation. Much can be done to overcome some of the prejudices against the use of legumes. The demonstration to mothers of children suffering from PCM that diets containing legumes cure the condition is one of the most convincing arguments for her to use the legumes at home. Such a change in the attitude of mothers has, in fact, been seen frequently.

Even in communities where legumes are accepted and consumed, there are strong preferences and prejudices for or against the use of certain legumes. This is particularly true of soybeans. In addition to the characteristic flavor and taste of the bean, the fact that it does not lend itself to the traditional way of home cooking in many countries (i.e. cooked into a soft pulp with water) has stood in the way of its acceptance. The use of soybean at the household level has, therefore, been limited to certain countries, mainly in Southeast Asia, where it is readily accepted. In other countries, soybean has gone largely into the preparation of industrially-processed food mixtures. Obviously, this has limited the widespread use of this legume.

Methods of preparation

a) Boiling and cooking. The most common method of preparing legumes for consumption is to dehusk the seeds, soak them in water, cook to a soft pulp and spice it before use. This procedure is simple, and in addition to inactivating toxic principles in the seed, also enhances the biological value. Such preparations are readily accepted.

b) Roasting and puffing. Roasting and puffing of legumes are also conventional methods of preparation. These procedures have the advantage that they impart a desirable flavor and taste, in addition to removing the toxic substances. Also, they do not increase the bulk of the legume, as cooking does, and that must be considered an important gain. Roasted and puffed legumes may be powdered, stored and used as "ready-to-eat" preparations for older infants and young children.

c) Sprouting. Many legumes are sprouted. After the seeds have been thoroughly soaked in water, they are spread out and in 24 to 48 hours, they germinate. The sprouted seeds are then eaten with or without addition of spices. This procedure has several advantages. The contents of B-complex vitamins and of ascorbic acid are known to increase considerably and the availability of iron is also reported to improve. This is believed to come about as a result of a decrease in phytin phosphorus, which is known to inhibit iron absorption. The carbohydrate moiety also undergoes changes, becoming more digestible. Germination does not, however, remove all toxic material found in legumes.

d) Fermentation. Fermented preparations from three legumes, soybean, groundnut and black gram, have been extensively used. They are readily accepted and the nutritive value of the

seed after fermentation is generally believed to be better than that of the unfermented product.

Manufactured products. Commercial preparations using groundnut and soy, in combination with other cereals, millets and milk solids have been developed for use by infants and children. Soymilk and milk prepared using groundnut protein isolate have been used as milk extenders in developing countries.

While such processed legume foods have the merit of being concentrated sources of protein in a ready-to-serve form, for reasons of cost and acceptability, their use at the present time is likely to be limited largely to people in urban and semiurban areas with reasonable levels of income. While efforts to develop and manufacture cheaper products must continue, primary emphasis must be placed on promoting greater consumption of legumes at the household level, as it is in this form that the poorer people living in rural areas can derive the benefit of better balanced diets without too much increase in cost.

GREEN LEAFY VEGETABLES

Nutritive value

Green leafy vegetables (GLV) are rich sources of a number of essential nutrients and their inclusion in diets greatly enhances the overall nutritional quality. Though there are wide variations in the chemical composition of the commonly-used edible varieties, GLV generally contain between 2-5g of protein, 400-1000mg of calcium, 20-30mg of iron, 3000-10,000mcg of carotene, 50-100mg of ascorbic acid, 40-120mcg of folates and 150-400mcg of riboflavin per 100g of edible portion. The protein concentration is low, and because of the amounts in which they are consumed, they do not contribute to any significant extent to the total protein intake. Many GLV contain relatively large amounts of oxalic acid and this is believed to limit the availability of its calcium. Similarly, the availability of iron in GLV is shown to be only between 3 and 5%, and this is believed to be due to the presence of phytin phosphorus. These factors notwithstanding, GLV provide good amounts of calcium and iron, because of their very high concentrations. GLV constitute the major, if not the sole, dietary source of vitamin A (β-carotene) for large segments of preschool children in many developing countries.

Amounts of GLV that can be fed

The nutrient content of GLV is known to be modified by storage and cooking procedures. The amount of this foodstuff which must be included in a diet, therefore, depends upon whether it is consumed in the raw state or after being cooked. Cooking does not alter the calcium and iron content of GLV, but significantly lowers the concentration of the vitamins. Losses in carotenes are not marked, but ascorbic acid is lost to a great extent. As much as 50-70% of the ascorbic acid originally present may be destroyed by conventional household cooking methods and cooking under pressure does not seem to modify these losses. The consumption of 30g of raw GLV per day will provide approximately 150-300mg calcium, 6-10mg iron, 1000-3000mcg carotene, 15-40mcg folates, 50-150mcg riboflavin and 15-30mg ascorbic acid. After cooking, the riboflavin, folate and ascorbic acid levels may be only one-third to one-half of that originally present. Even these amounts contribute towards meeting a considerable proportion of the daily needs of these nutrients.

Consumption of raw GLV has obvious advantages. However, one of the important considerations of their use in the raw state, particularly in rural areas of developing countries, is the risk of introducing bacterial infections and parasitic infestations.

Bulk will not pose any problems in the feeding of GLV, since there is actual shrinkage in volume after cooking.

Problems connected with feeding of green leafy vegetables

Acceptability. One of the major problems of including GLV in the diet is the strong food beliefs and prejudices held by many rural communities. They are believed to be unsuitable foods for infants, children and even for pregnant and lactating women. GLV are considered to be

"cold" foods and to predispose to gastro-intestinal upset. In addition, GLV are considered to be nonprestige foods. As in the case of legumes, educating the mother regarding the nutritional qualities of GLV, coupled with demonstration of suitable recipes, is perhaps the most important step to be taken to make her accept GLV.

Nitrite poisoning. A number of fatal accidents among infants in European countries following the use of processed preparations containing spinach led to the observation that the nitrate in these preparations was responsible for the toxicity. When nitrate fertilizers are used to grow vegetables, the nitrate content shows a 3- to 12-fold increase. After ingestion, nitrates are converted to nitrites and the absorbed nitrites combine with circulating hemoglobin, leading to the formation of methemoglobin. The oxygen-carrying capacity is greatly lowered, leading to cyanosis, hypoxia, vomiting, shock, and if severe, can lead to coma and death. Nitrates are converted to nitrites in the intestinal tract by bacterial action. In young infants, because of the relatively higher pH, bacteria such as *Escherichia coli* are found at higher enteric levels, thus facilitating reduction of nitrate to nitrate in the small gut. It is for this reason that only young infants develop signs of poisoning, while older infants and children rarely suffer from nitrite poisoning through they ingest nitrates.

Processed preparations of spinach, which contain negligible amounts of nitrite when fresh, have been shown to contain increasingly greater amounts after thawing from a frozen condition. The nitrate content of spinach is obviously of importance in this connection. So far this problem seems to be of importance only in technologically-advanced countries where the practice of feeding young infants on canned spinach is prevalent.

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THE ROLE OF LEGUMES AND DARK GREEN LEAFY VEGETABLES IN DOMESTIC MULTIMIXES FOR THE TRANSITIONAL

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A major concern in the prevention of protein-calorie malnutrition of early childhood is always the provision of a diet for the "transitional"* which is economical, easily prepared in the home, digestible, culturally acceptable, tolerated by the child's intestinal

* A young child from about six months to two years of age.

tract, and which contains not only the protein required, but also calories, vitamins and minerals needed for this rapidly growing phase of life.

Processed foods can play a considerable role in developing countries, both through commercial outlets in periurban areas and when distributed through health services. However, in many if not most less developed countries, they can reach only a small percentage of the children at risk, most of whom will be living in rural areas, often largely outside a monetary economy. Recent emphasis has been given to the need for home-made weaning foods which are of scientifically-proven value and are yet within the restraints of the kitchen, culture, economy and availability of foods (1-4). The situation has been well put in relation to circumstances in Baroda, India, in a plea for suitable foods which can bridge breast milk and "hard roti and spiced dhal" (5).

PRINCIPLE OF MULTIMIXES

The use of food groups for practical nutrition education dates back to the mid-1920's, when this concept was introduced by the U.S. Department of Agriculture. Modifications and developments of the original groups have evolved and have been used with considerable educational value in some parts of the world. However, recent analyses of the food groups used in at least some developing countries indicate that they are often inappropriate to the local circumstances, especially in relation to the customary dietary pattern, to the range of foods available, and to the cultural classification of foods.

From a more practical point of view in developing countries, the principle of multimixes has been introduced as being helpful for diets for all age groups, but especially for young children. The main feature of the multimix approach may be termed the "staple plus", which then needs to be interpreted in relation to the two major categories of staple eaten in different parts of the world: the cereal group, such as rice, wheat, barley, etc., and the TPB group (tuber-plantain-breadfruit). In the multimix concept, five categories of food are usually considered: the staple (either cereal or TPB), legumes (pulses), DGLV (dark green leafy vegetables), animal products and compact calories, such as oils and sugar.

Domestic multimixes for young children are based on the local staple, which is usually also the cultural "superfood". Thus, in most of the world, where cereals are the staples, the basic double mix can be made of cereal-legume mixtures, with all the protein and the full range of essential amino acids being achieved in this way. By contrast, in cultures with a TPB staple and, therefore, with a low-protein (1%), high-water and high-cellulose basic food, it will be necessary for the double mix to be of staple plus animal product. In any village-level multimix, the usefulness of DGLV needs emphasis since they can supply the vitamins and minerals often lacking in both cereal and TPB staples.

Basically, therefore, in most of the world where animal products are in very short supply, legumes and DGLV may be considered of special potential in multimixes for young children. Thus it is extremely important to examine present evidence concerning the acceptability, digestibility, and other relevant aspects concerning the use or failure to use legumes and DGLV in young child feeding in various cultures in different parts of the world.

LEGUMES

A variety of legumes are available in different parts of the world, with certain species dominant in particular ecosystems. Large numbers of different varieties are to be found for all species (6). Dry legumes are the best plant sources of protein. Fresh legumes are also dietary sources of thiamine, niacin, riboflavin, calcium, folate, iron and vitamin C; sprouting increases the content of thiamine and riboflavin, as well as vitamin C.

Problems in weaning multimixes

In the Western world, and in some areas that have been influenced during colonial times and indeed by modern dietary example, legumes

have a low status and are often considered as "poor man's meat". Paradoxically, in the English language, a variety of different terms have been used with rather a laudatory sense, as in "bean feast" and "full of beans". In India and in some other Asian countries, the legumes have a high prestige and status. In all cultures, the different types of legumes are classified in various ways which can be extremely important and relevant in relation to their use in weaning multimixes. In Bengal (India) for example, one legume is regarded as so potent that it is classified as nonvegetarian. In southern India, legumes may be classified as vayu, which is related to the level of flatulence produced. These classifications often indicate to others the type of legume and the age at which it is felt culturally desirable and safe to introduce them into the diet of young children.

Although legumes are well known as an article of diet, they are not popular for feeding young children in developing countries. More quantitative information is required on the prevalent practice of feeding legumes to children and the amount commonly fed at one time. In many areas, legumes are used as part of the sauce or relish with which the main item of the meal, the staple, is eaten. In this case, it may be difficult for the young child to acquire sufficient of this relatively high-protein, semi-solid sauce or relish from the family dish, especially with the inexpert, not-very-dexterous finger movements of a young child.

Various toxins have been reported to occur in different legume varieties, but these toxins are not significant from the practical point of view in child feeding. A considerable number of studies have been made on the trypsin inhibitor present in some legumes, notably the soybean. The results suggest that most of the legume toxins are eliminated in the course of ordinary cooking practiced in the home.

Digestibility of legumes also shows great species variation and even within each species certain varieties are more difficult to digest than others. The inherent characteristics of the legume as well as the method of preparation influence intestinal digestibility. The inherent characteristics could be the firmness of the gums between husk and cotyledons as well as other physical and biochemical factors which remain to be unravelled. The methods of preparation include milling, husking, mashing and sieving after cooking. The quantity of legume consumed in a meal and the condition of the digestive tract are also important factors. Experience in the use of legumes by different communities has enabled them to classify the degree of digestibility of various legumes: for example, in India, the chick pea is considered relatively indigestible compared to the green gram.

The degree of intestinal gas or flatulence is another factor which determines the maternal acceptance of legumes for young child feeding. Studies have shown that five main gases are involved: nitrogen, oxygen, hydrogen, methane and carbon dioxide. The two most important of these are methane and hydrogen. The former appears to be more related to human genetic variation and present evidence suggests that one-third of many populations form and excrete methane, apparently on a genetic, constitutional basis.

Of great importance, however, is the fact that legumes contain oligosaccharides, including stachyose and raffinose. These compounds, made up of several simple sugars linked together, resist digestion and pass to the large intestines where they are ingested by various microorganisms in the colon with subsequent production of hydrogen.

Practical approaches

The choice of legumes in multimixes for young child feeding will depend on the availability, cultural preferences, knowledge of nutritional composition, cooking quality, and apparent digestibility. Certain legumes may seem to be particularly appropriate for different reasons. Thus, Bengal gram makes a fine paste, but seems culturally unacceptable for feeding young children in Bengal. The peanut can play a particularly useful role in that it not only is a source of protein, but also of compact calories. Soybean preparations, such as those developed over hundreds of years in Mongolo-Malaya, can play a special part since these preparations, including such items as tofu and tempeh, are usually particularly digestible.

The amount of legume that can be administered to and tolerated by young children in multimixes is influenced by the nutritional composition of the other foods in the multimix, the extent to which it is proposed to fill the nutritional gaps with legumes, and the digestibility of the particular legume. A simplified guide to the amount of legume needed in a cereal-legume double mix to achieve ND_pCal 7-8% has been prepared (1). The level tolerable without digestive upset is less easy to define, and depends on many factors. It seems probably wisest to introduce legumes in a relatively dilute form, increasing the content of pulse as the child gets used to this new food. It seems likely that the phenomenon of "intestinal adaptability" to newly-introduced foods may be applicable to legumes too.

Legumes are consumed in various forms, determined largely by the cultural preference of the community. Some of these are: green legumes in the pod; germinated or sprouted legumes; special legume preparations, such as have been developed with soybean foods in China and Japan, which can make their incorporation easier into domestic multimixes for young children; various flours and split legumes, such as the dhals of India; toasted or roasted legumes; and fresh or dry whole grains cooked in the form of a smooth paste. Usually cooking will be achieved by boiling, followed by mashing or sieving. Skins must be removed, by prior soaking or following boiling. The additional length of time required for the cooking of pulses needs consideration in relation to time consumed by the mother and particularly the amount of fuel used. The method of preparation and cooking must be based on local practices, as with the plantain leaf ettu packets used in Buganda (7). There is undoubtedly a great need for applied research and development of domestic or "grass roots" food technology to simplify the home preparation and home cooking of legumes so that the product will be maximally digestible with minimal destruction of nutrients, and its preparation will cause the least expenditure on fuel.

GREEN LEAFY VEGETABLES

Dark green leafy vegetables contain 3 to 6% protein in the fresh state and between 20 and 40% when dried. The protein of DGLV is usually high in lysine and tryptophan, so that they are supplementary to cereals in the same way as legumes. In particular, they may have a special antipellagragenic supplementary effect when eaten with corn (maize) (2). They are also excellent sources of β-carotene, folic acid, niacin, vitamin C and calcium. It is perhaps worth emphasizing the great difference between dark green leafy vegetables* and anemic vegetables of the lettuce and cabbage groups. In fact, it is not too much to say that the former represent age-old mineral and vitamin supplements for more traditional village communities and have done so for thousands of years (8).

The consumption of dark green leafy vegetables is not popular and in many areas of the developing world their use is diminishing (9). This has been well put in the title of a paper, "Vegetable greens - a tropical underdevelopment" (10). They are considered to be low status foods, perhaps because they are inexpensive or grow wild or minimally cultivated in home gardens.

Leafy vegetables may be eaten as fresh leaves, particularly young leaves, or in the powdered form after sun-drying and/or smoking. A very wide range of leafy vegetables is often actually or potentially available. They may range through such plants such as cassava, sweet potato, a variety of different types of wild amaranthus, colocasia, and many others, including wild species (11). It is, therefore, important to know those available in the particular area, especially during the dry season, which often include the leaves of various trees.

Particular work has been done on cassava leaves (2, 12, 13), which contain between 30 and 40% of protein when dried and 7% in fresh young leaves. The leaves are shredded and the

*In general, the darkness of the green color of leaves is proportional to β-carotene levels.

cyanogenic glucosides present are removed completely by boiling for a few to several minutes, depending on the cassava variety.

Problems in weaning multimixes

In many parts of the world, leafy vegetables figure prominently in the sauce eaten with the staple. In Ghana, for example, the palaver sauce commonly used is usually based on cocoyam leaves. Nevertheless, leafy vegetables are often considered unsuitable as food for young children during the transitional period. The dark color of the leaf preparation is often considered to be indigestible for the young child. The digestibility appears to be related to the amount of crude fiber, mucilages and gums present. Young leaves with the fiber removed are the most digestible.

Practical approaches

The preliminary step is to obtain information on the range of different edible species growing in a particular area,their availability during different seasons of the year, the nutrient content and toxic factors,if any, and the extent of their popularity as food items and acceptability for child feeding by the mothers concerned. Studies are necessary to determine the quantity of a leafy vegetable which may be fed to the young child in a multimix. A significant consideration besides acceptability and tolerance is the nutritional purpose of the leafy vegetable in the particular mixture. This can be principally in relation to the complementary effect of the protein present, when combined with the protein of cereals in multimixes. Alternatively, the leaves may be fed for the content of other nutrients such as folic acid and β-carotene. In the prevention of avitaminosis A, it has been shown that children may take, digest and benefit from 30 grams of leafy vegetable each day, supplying them with 2,500 to 3,750 international units of β-carotene (14).

FUTURE NEEDS

It is apparent from this very brief note on this complex subject that much work remains to be done. Firstly, research is needed on both legumes and leafy vegetables, on their nutritional composition, digestibility (both *in vitro* and *in vivo*) and in particular in relation to the production of flatulence, and their cooking properties. Basically, the protein concentration and the first-limiting amino acid should be major factors; but in addition, the content of various other nutrients can be exceedingly significant, especially β-carotene and folic acid. As an immediate practical step, it is suggested that there is a need for a review and updating of all available information on legumes and leafy vegetables in young child feeding. It seems very likely that considerable information may be buried in the literature and at various centers throughout the world, which could easily be accessible if a three-months study were to be undertaken through various bibliographies and through correspondence.

Secondly, the status of both legumes and leafy vegetables needs considerable emphasis and endorsement. It seems likely that with regard to legumes this may well come about. In particular, the concept of initiating centers or institutes to investigate the agricultural production and other aspects of legumes will be very helpful in this regard. Also, various recent books* published in the Western world may help to endorse their respectability and nutritional desirability, for example, from the point of view of the prevention of atheroma.

Thirdly, studies are needed into the domestic technology that could be used in making better use of legumes and leafy vegetables. For example, the village application of the production of "quick-cooking" legumes, by vacuum treatment and soaking in various simple solutions, such as sodium chloride and sodium bicarbonate, needs investigation. These have been shown to reduce cooking time by 80-90% and flatulence by 50% (15).

Fourthly, investigation is needed into the best way of trying to introduce legumes and leafy vegetables into multimixes. Undoubtedly, one of these will be through their use in nutrition

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*"The Benevolent Bean" (1967) M. and A. Kays, Doubleday and Co.; "The Complete Bean Book" (1967) V. Bennett, Prentice-Hall, Inc.

rehabilitation units, in which mothers can prepare the multimixes themselves and see their own and other children improving and being able to digest and deal with such foods easily. An alternative approach may perhaps be that employed with the Hyderabad mixture, in which mothers of malnourished children discharged from the ward are given small plastic envelopes containing powdered mixtures of various vegetable protein foods, including legumes. These can be used at home, and if the mother observes her child to be improving, it may then be possible to persuade her more easily to use the ingredients of the mixture prepared domestically from actual sources in the home or village.

Likewise, in certain countries of "intermediate" development, such as in parts of the Caribbean, introduction may be facilitated by the presence of prestigious infant foods already available in the shops, containing legumes and leafy vegetables, which are already being bought readily.

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LEGUMES AND GREEN LEAFY VEGETABLES IN INFANT AND YOUNG CHILD NUTRITION

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LEGUMES

Legumes with their relatively high protein content appear to offer a partial solution to the problem of increasing world protein needs. In many countries, however, much of the legumes produced may be used for feeding cattle. Infants and children in need of extra protein in developing countries are not fed legumes in the first year or two of life; this is related to food habits, economics or even food prejudices against their use in infancy (1).

Use of legumes as human food

Figures of daily per caput consumption of legumes are reported to be 65-71 grams for India, 23 grams for Indonesia, 42 grams for China, 30-40 grams for Africa (a figure as high as 400 grams is reported for certain tribes in Uganda), 25-50 grams for the Middle East, 20-60 grams for Central and South America and 16 grams for Europe (2). Seasonal and cultural variations in legume consumption occur in most countries.

The advantages of the use of legumes as human food are that they are easily cultivated with a large yield of protein per unit area for some species, inexpensive, and already form part of the diet in most developing countries. Legumes are also one of the richest sources of vegetable protein and contain thiamine, folic acid and minerals. Properly processed legumes have a relatively low fiber content (5-10% of dry matter) and are reported to minimize the tendency to diarrhea commonly prevalent among children of developing countries.

Some of the problems in the use of legumes as human food are the need for prolonged cooking, the expense of which cannot be easily afforded by low income populations and the prevalent prejudices and taboos against their use, especially for children, in many developing countries.

Acceptability and tolerance

The digestibility, absorption and tolerance depends on the type of legume consumed, the method of home processing, the amount consumed and the condition of the digestive tract. In adults a consumption of more than 60-100 grams of legume daily will cause digestive disturbance (2). The much larger amounts consumed by certain African communities, however, are not associated with digestive disturbances although stools contain appreciable amounts of undigested food. It has been reported that an intake as high as 129 grams daily in Rwanda and Burundi is easily tolerated by children one to two years old (3). A trypsin-inhibiting factor is present in most raw legumes, especially soybeans. Heating and fermentation destroy this factor. Other substances present in raw legumes which may affect digestibility are saponins, glycosides and protein conjugates with phytin and hemicelluloses. Most of these are eliminated by cooking or soaking. The high phytic acid content can interfere with absorption of iron and calcium.

Consumption of large amounts of insufficiently cooked legumes may result in gas formation. A meal of 100 grams of cooked white beans was found to increase flatus formation 5-7 hours later with a peak of 130-170ml of gas in 30 minutes (4). The excess gas is mainly carbon dioxide liberated by bacterial action, mostly of the clostridium group. It is believed that the compounds in beans responsible for flatus production are oligosaccharides such as raffinose, a trisaccharide, and stachyose, a tetrasaccharide. The human intestinal tract does not produce enzymes to split oligo-saccharides. Other products of bacterial fermentation may cause spasm and irritation of the intestinal mucosa and abdominal discomfort. Such symptoms, however, are rare with the usual amounts of legumes consumed.

Quality of legume protein

Legume protein is a poor source of the sulfur-containing amino acids, methionine and cystine. Many legumes are also deficient in tryptophan, but they are usually rich in lysine. For young child feeding the marginal tryptophan content will require provision of niacin to spare available tryptophan and of pyridoxine to assure maximal utilization of tryptophan. Legume protein appears to require triple the normal level of tryptophan in order to equal animal protein. Excessive heating during cooking in the presence of high humidity and high sugar content may result in a loss of amino acids such as lysine, histidine, and arginine.

Toxic substances

In certain individuals with a deficiency of erythrocyte glucose-6-phosphate dehydrogenase (G6PD), ingestion of broad beans (*Vicia faba*) may result in acute hemolytic crisis. The fact that not all G6PD-deficient individuals develop this reaction suggests that a toxic factor in the broad beans is responsible. Favism is more liable to occur when raw beans are ingested. Among the toxic factors postulated are vicine, covicine and L-dopa (5,6). The relative frequency of G6PD deficiency in populations in the Mediterranean area (7) renders the problem important.

A spastic paralysis which follows ingestion of *Lathyrus sativus* is related to the amount and duration of ingestion of the offending legume. Other toxic components of some legumes include cyanogenic glucosides, poisonous alkaloids, toxic saponins, goiterogenic factors, hemagglutinins and anticoagulant factors. Most of these toxic substances are eliminated by simple cooking or soaking procedures.

Contamination of legumes by toxic substances is exemplified by the aflatoxin of *Aspergillus flavus* in groundnuts. Allergic reactions to legumes have been rarely reported except in the malnourished.

Legumes as a food for infants and children

Legumes are rarely introduced in the infants' diet before the age of two years. In Egypt, Tunisia, Syria, Lebanon and other Middle Eastern countries small amounts of legume purees equivalent to about 30-50 grams of dry material are well tolerated by four-month-old infants. An intake of 30 grams of legumes daily by children consuming an 1100-calorie cereal diet will raise the protein value of the diet to optimal levels (2). In Dakar, 50-80 grams of peanut flour fed daily are reported to be tolerated well by healthy infants 5-12 months old, but larger quantities were poorly digested (8).

Soybean preparations simulating milk have been used in developed countries for a long time for feeding infants allergic to milk. However, the elaborate manufacturing processes make the product more expensive than milk. The development of such mixtures should not be allowed to interfere with efforts to encourage and promote breast feeding in developing countries.

The effect of legume-enriched foods on growth of normal infants and preschool children has been studied by several investigators. The use of a peanut-milk mixture (India), a chick pea mixture (Lebanon) and a sour soy-maize mixture (Nigeria) have all been found to be well tolerated by young children and nutritionally effective.

The malnourished infant and child present a special problem in feeding with legumes. Their comparatively poor digestive capacity underlines the need for special caution in the amount and type of legumes fed. The handicaps of the malnourished children would probably explain the slower beneficial response seen in such children when vegetable protein mixtures are used in the treatment rather than milk or animal protein.

Various attempts have been made to introduce processed legumes in infant and child feeding, especially in developing countries. Rarely used alone as a complete infant food, the legumes are usually mixed with cereals and oilseed concentrates in the production of processed protein-rich foods and frequently also with a small proportion of animal protein in the form of milk. Various additives such as amino acids, vitamins, minerals, etc., are usually added to ensure optimal nutritive quality.

Summary

Legumes are among the less-expensive, locally-available and acceptable sources of protein in many developing countries. With proper home processing and cooking and in suitable amounts they are tolerated well by normal children. With a few exceptions, most of the legumes, if processed properly, are free of toxic side effects. Their inclusion in suitable amounts in diets of older infants and young children in developing countries will greatly improve protein intake and promote better growth. For malnourished children, however, some animal protein would be necessary for good response.

GREEN LEAFY VEGETABLES

There is insufficient interest in the role of green leafy vegetables as a source of protein and other nutrients in human nutrition. Green leafy vegetables are widely available in the wet tropics where people are in real need of them (9). Many species of edible leaves contain as much as 30-40% protein on a dry weight basis (10).

Edible green leaves represent an inexpensive source of protein supplement in a cereal-legume diet. They can be grown with minimal effort in kitchen gardens and many species are already familiar to the people and form a part of the local diet. Proteins from edible green leafy vegetables are considered to be of better quality than most seed proteins in their amino acid composition, although methionine is the limiting amino acid in most of them. All leafy vegetables have a nearly uniform composition of amino acids and are excellent sources of other nutrients such as iron, vitamin C, vitamin A, thiamine, riboflavin and folate.

Green leaves are easily perishable after picking and preservation is expensive. Hence, it is advantageous to pick leaves from backyard gardens in quantities which can be consumed at the next meal. The plants need a good water supply and protection against weeds and marauders, especially goats.

Although green leaves have a uniform protein composition, they are all not equally good as protein supplements, probably due to formation of indigestible complexes with other components during cooking (9). It is believed that the leaf lipids, which are mainly unsaturated, form indigestible complexes with the proteins. The high fiber (20-30% of dry weight) and high moisture content limit the amount of fresh leaves that can be consumed in the raw state. The high oxalic acid content may also interfere with the absorption of the minerals.

The digestibility varies with the species, age of the leaf, extent of processing or cooking and amount of stem in the mixture. Any variations in the protein availability will be the result of poor digestibility rather than amino acid content (11). The high fiber content, unless separated mechanically, would interfere with digestion and cause diarrhea.

Ideally, use should be made of leaves that are by-products of some other edible crop in the area, such as beans and peas, early potatoes, sweet potatoes, groundnuts, sugar beets, etc. Table I shows the composition of some commonly-consumed leaves of vegetables in Egypt and the Middle East. Powdered baobab leaves are consumed in West Africa. In the Congo, as much as one pound of cassava leaves might be consumed daily. In New Guinea some ferns and sweet potato leaves are eaten. Green leaves are, however, seldom eaten daily or in quantities greater than 10-30 grams dry weight in most countries. Attempts to include dry leaf protein flour in the natural diets met with success in West Africa, Southeast India and New Guinea (12). However, in most developing countries leafy vegetables are introduced into the child's diet after the age of 1-2 years and only in small amounts. Leaf protein concentrate has been found capable of replacing 50-74% of milk protein in children recovering from protein malnutrition with only a slight reduction in nitrogen retention and absorption (13). However, in the dry processed form the unfamiliar green color might render them unattractive as human food.

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TABLE I. COMPOSITION OF LEAVES

Botanical name	English name	Edible portion, %	Water, %	Protein, %	Fat, %	Carbohydrate, %	Fiber, %
Allium kurrat	Egyptian leek	100	94.06	1.33	0.18	2.15	0.91
Corchorus olitorius	Jew's mallow	91	93.5	1.6	0.14	2.7	0.9
Malva parviflora	Egyptian mallow	45.8	86.28	4.21	0.16	6.94	0.94
Portulaca oleracea	purslane	90.05	91.96	1.47	0.19	3.33	0.83
Raphanus sativus	radish	100	93.57	1.91	0.05	2.28	0.83
Spinacia oleracea	spinach	87.3	90.92	2.36	0.18	3.84	0.77
Trigonella foenumgraecum	fenugreek	43.1	87.56	4.58	0.25	4.89	1.37

THE USE OF CHICK PEA IN INFANT FEEDING

by M. A. Tagle, Department of Nutrition, Faculty of Medicine,
University of Chile, Santiago

A biological study of legumes grown in Chile has shown that the chick pea (Cicer arietinum) has the best protein quality, even better than soybeans. Thus it was of interest to find the best formulation for its use in child feeding. Several mixtures were tried and it was found that 80 parts of precooked chick pea, 20 parts of defatted powdered milk and 0.2% DL-methionine constituted a very good mixture, attaining an NPU value of 77.1 at 10% protein, a value similar to that of casein. The mixture has 22.2% protein, a figure of 60.6 for operative NPU and a protein value of 13.5 NDpCal%.

The formula was used as the sole protein source for infant feeding in different trials. The complete formula used in bottle feeding was chick-pea mixture, 81.5; sugar, 8.5; sunflower oil, 9.0; and vitamins and minerals, 1. The bottle feeding product is prepared at 20% concentration and boiled 8-10 minutes. α-Amylase was used as a hydrolyzing agent. In the first trial the enzyme, in a water solution, was added at the end of the boiling period at about 5mg of enzyme per liter. This procedure was later changed to adding the enzyme directly to the mixture, using a slightly higher concentration. One hundred milliliters of the finished preparation (20%) supplies 84.8 calories, 3.4g protein and 2.7g fat.

Four normal infants, aged two to three months, were fed exclusively on this formula for a minimum period of two months (60 to 84 days). Strict clinical control was observed during the trial, weight and height were carefully registered, and dietary intake was determined by weighing each bottle before and after feeding. Feces were observed daily.

This formula was very well accepted; no gastrointestinal disturbance was detected or the presence of meteorism. Well-formed feces and a tendency to normalize loose stools or diarrhea were verified. In the four cases weight and height gain was extremely good; all finished the study in different percentiles for weight and height, significantly higher than those they had at the beginning of the trial.

In a second experimental stage the formula was used as the sole food and the only therapy in the treatment of children with third-degree malnutrition and suffering from long-term diarrhea. Thirteen infants of less than one year of age, who had suffered diarrhea for 50 days on the average, were studied. The formula stopped diarrhea in an average of 2.4 days and in 8 of the 13 cases diarrhea disappeared in less than 24 hours. At the same time, in spite of several intercurrent infections, weight and height gain were very good. The mean daily weight increment observed, expressed as a percentage of what could be expected for the age, was 213%.

In a third experimental stage, still in progress, the formula is being applied to the feeding and therapy of infants with diarrhea and dehydration. Infants aged from 24 days to one year are being divided into two groups; one receives milk feeding according to the usual practice for this diagnosis, and the other group receives the chick-pea formula. Both groups are completely comparable in nutritional state, age, sex, extent and severity of signs and symptoms, therapy, treatment, etc. The experimental period is eight days.

The first analysis of about 130 cases gave the following results:
a) the percentage of the daily dietary prescription that was ingested and the tolerance to the diet was excellent both for milk and for our formula;
b) on the seventh day only 28.6% of the milk-fed infants had normal feces, while in the chick-pea-fed group this percentage was 77.8%; and
c) 40% of the infants fed on chick pea normalize their stools in 2 to 4 days, while during the same time period only 5.7% of those fed on milk showed normal feces.

With these results, it is planned to use our formula as a therapeutic food in the next summer's campaign against diarrhea.

USE OF LEGUMES AND GREEN LEAFY VEGETABLES FOR INFANT AND YOUNG CHILD FEEDING: SUMMARY OF RESULTS OF STUDIES IN THREE DIFFERENT PARTS OF INDIA

RURAL CENTRAL INDIA*

A dietary and attitude survey was conducted in the rural areas of Madhya Pradesh** in April and May, 1972, as an integral part of the baseline data collection of Project Poshak, an integrated preschool child pilot study (see PAG Bulletin II, No. 4, 1972).

The survey enabled the quantification of the level of consumption by infants and children 6 to 36 months old. Beliefs concerning legume feeding were also studied. A total of 360 families in 12 villages in one tribal (Dhar) and one nontribal (Sehore) district were included in the study.

Data obtained through the oral questionnaire method and relating to 216 families of the sample mentioned above were analyzed.

Similarly, attitudes regarding food, child care and health were ascertained in a parallel survey on 261 families.

The consolidated findings of the survey were:

1. A great deal of variation existed in the amounts of legumes consumed even within each age category.

2. The percentage of children consuming dry legumes (all varieties) increased markedly with increasing age and was found to be approximately 30 per cent of 34 families with infants between 6 and 12 months; 70 per cent of 94 families with children between 12 and 24 months; and 85 per cent of 88 families with children between 24 and 36 months.

3. The mean level of intake remained around 25g/day, among the children who do consume dhal (split dry legume).

4. Of all varieties of dhals/legumes eaten, tuvar dhal (Cajanus cajan) is the most common, followed by besan (Cicer arietinum flour), mung dhal (Phaseolus aureus), chana dhal (Cicer arietinum), and lastly hola (fresh chana in the pod).

5. The legumes are cooked and served as a thick to watery sauce to accompany the staple chapatti, soft-boiled with rice to form a khicheri (a special, easily digestible convalescent food), or puffed roasted chana is often eaten as a snack by the toddler. Besan (chana flour) is mostly served as a thick soup called "khadhi" or it is used occasionally for "bhajjiyas" (deep fried bits of vegetable in besan batter), for basan laddoos (balls made out of chana flour, fat and jaggery), or for making chapatties out of wheat/maize and chana flour. Hola is considered a vegetable and is either used as such, or is eaten by the entire rural community in generous quantities in season; however, it is considered indigestible for the very young child.

The results of the survey indicated that "strength", "flatulence" and "heat" are qualities most often associated with the consumption of legumes.

The quality of flatulence, attributed to dry legumes, in this survey is consistent with the practice and beliefs of the Ayurvedic school of medicine. A preliminary survey indicated that all are classified "gharam", implying hot and as "vat", implying flatulence. The only exception is mung (Phaseolus aureus), which is considered "light", easily digestible and allowed under all conditions. The supernatant liquid obtained on cooking mung dhal is considered beneficial for convalescence. Urad (Phaseolus mungo) is considered "heavy" in addition to being flatulent. For the child under

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**Central Indian state.

two years of age, mung and tuvar are allowed and a well-mashed soup form for the infant. Dhals, considered to be constipating, are discouraged during respiratory illnesses as contributing to the formation of phlegm. The flatulence factor seemed to be the primary cause for dissuading dry legume consumption among very young children, although their "strength-giving" quality is acknowledged.

GUJARAT STATE*

Several feeding trials on infants and young children (8 months to 5 years of age) have been carried out in the rural play center of the University of Baroda. Several recipes** using wheat and Bengal gram combinations have been evolved with essentially traditional cooking procedures. The cereal: legume ratio was 4:1 and recipes which included leafy vegetables contained 30 grams.

The studies were carried out in infants and children aged 8 months to 5 years, lasted for several months and did not cause any ill effects in the recipients. Indeed, it was noted that the feeding program resulted in an improvement in their nutritional status.

Even young children 8 months to 1 year were found to tolerate legumes such as Bengal gram if suitably processed and mixed with a cereal in amounts equal to 30-40 grams. The processing was important since it improved the taste and acceptability. Fifteen to 30 grams of leafy vegetables suitably prepared for children 8 months to 2 years could be fed daily without any problem.

For older children, processing helped to increase the amount of food consumed and 100 to 120 grams of cereal plus legume could be fed in one meal. In one study, the two- to five-year-olds were given mixed in the porridge an amount of peanut making the ratio wheat: Bengal gram: peanut = 1:1:2. This was well tolerated. Children between 2 and 5 years tolerated 30-50g of leafy vegetables per day. The grams seemed to be better tolerated than beans.

SOUTH INDIA***

A mixture of legumes, cereals and oilseeds were used in the feeding studies conducted at the Sri Avinashilingam Home Science College, Coimbatore. The legumes and cereals used were locally available and the preparation of the recipes were simple and least time-consuming, to suit the rural mothers. Green leafy vegetables have been fed by incorporating them in recipes of legumes and cereals so as to suit the children's taste and preferences.

For the older infant (6 months to 1 year), legumes and green leafy vegetables were fed in the form of a soup after straining the well-cooked and mashed mixtures. For the toddler of one year to 3 years, the cereal-pulse-leafy vegetable mixture was used for the preparation of traditional recipes****

The mixture provided 25g cereal and 10g legume per feed for older infants and 40g cereal and 20g legume for children aged 1 to 3 years. Recipes with legume and green leafy vegetables provided 10g legume and 15g green leafy vegetables in the case of older infants and 30g each in the case of children 1 to 3 years. Some of the preparations contained more than one legume.

The legumes employed in the study were Cicer arietinum, Phaseolus aureus, Phaseolus mungo, Cajanus cajan and Dolichos biflorus. Among the green leafy vegetables, amaranthus (A. spinosus) and araikeerai (A. tristis) were more acceptable to children than agathi (Sesbania grandiflore) and drumstick (Moringa oleifera) leaves. The latter

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** Information on the recipes may be obtained from the author.

*** Rajammal P. Devadas, Sri Avinashilingam Home Science College for Women, Coimbatore, India.

**** Details of the recipes can be obtained directly from the author.

varieties were more coarse and bitter to taste.

The acceptability to children in long-term feeding of these recipes was found to be good and no problems of digestibility or other alimentary disturbances were encountered.

Green leafy vegetables had to be prepared always with other ingredients such as legumes and cereals, since preparations containing green leafy vegetables alone were not accepted by infants.

FLATUS PRODUCTION IN CHILDREN FED LEGUME DIETS

by M. Narayana Rao, K. S. Shurpalekar, E. E. Sundaravalli and T. R. Doraiswamy, Central Food Technological Research Institute, Mysore, India

The ingestion of large quantities of legumes is known to cause flatulence in experimental animals and humans (1-4). This characteristic may discourage the use of these low-cost, high-protein foods for young child feeding. The following study was conducted to determine the effect of various legumes commonly consumed in South India on flatus production in older children.

Four girls aged 9 to 11 years, weighing 42-54 pounds and residing in a local boarding home were selected for the study. Their regular diet contained 30 grams of red gram (Cajanus cajan) per day per child. The subjects were made to lie comfortably on a bed and a lubricated catheter was inserted approximately 15cm into the rectum. The flatus was collected using slightly modified Steggarda equipment (4).

Flatus collections were done three hours after lunch and dinner on the fourth and sixth day of feeding. The duration of each collection was two hours. The basal diet was supplemented with 100g of dhal (split, dehusked legume), 50g at lunch time and 50g at dinner. The dhal was cooked in the way it is usually consumed in Indian diets. Bengal gram (Cicer arietinum), black gram (Phaseolus mungo), green gram (Phaseolus radiatus) and red gram (Cajanus cajan) were tested.

The results are given in Table I. The inclusion of 100g/day of legumes in a basal diet which contained 30g of legume resulted in increased quantities of flatus. Among the legumes tested, flatus production was in the following decreasing order: Bengal gram > black gram > red gram > green gram.

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TABLE I. FLATUS PRODUCTION IN CHILDREN

	Flatus volume, ml				
	1st day		2nd day		
Diet	after lunch	after dinner	after lunch	after dinner	average ml/hour
Basal	62	66	62	57	31
Bengal gram	188	197	173	182	93
Red gram	146	149	136	149	73
Black gram	159	166	159	168	82
Green gram	121	124	113	120	60

Abidjan, Ivory Coast

COLLOQUIUM ON BREAST FEEDING*

(14 - 18 November 1972)

Breast feeding has been the subject of a series of international meetings organized in Abidjan by the International Children's Centre, in collaboration with the government of the Ivory Coast Republic, UNICEF, FAO and the local Board of WHO for Africa.

Fifty-four participants from 17 countries have met first in a colloquium. They came from Africa (Cameroon, Ivory Coast, Dahomey, Mali, Niger, Senegal, Togo and Tunisia), America (Brazil, Chile and the United States), Australia and Europe (Belgium, France, Sweden, and Turkey). They comprised doctors, midwives, pharmacists, nurses and representatives of international organizations.

The colloquium was able to review the scientific ideas and practical facts supporting breast feeding, which is especially urgent in rapidly urbanizing areas in developing countries, as well as in richer population groups. Education and social measures can be based upon an analysis of the development of milk feeding in different geographical and social environments, the physiology of lactation (emphasizing the important role of maternal nutrition, the importance of psychosocial stimulation and close mother-child relationships), and the health effects of closely-spaced pregnancies. Lactation may have neither a contraceptive effect nor delay the resumption of the menstrual cycle for more than a few weeks.

Discussions dealt with the comparative savings provided by breast feeding since food supplementation of the mother is more economical than artificial feeding of the child.

Also underlined was the major role of members of the health services and staff who could deeply influence the evolution of milk feeding, as does the behavior of higher-class women who can afford to buy various artificial foods. Breast feeding has been approached in conjunction with quality and availability of weaning foods. It has also been studied in relation to social measures allowing mothers to breast feed their children and to return to work at the same time.

The colloquium, which was presided over by Professors Robert Debré, Chairman of the International Children's Centre, and Hippolyte Ayé, Ministry for Public Health and Population of the Ivory Coast, was initiated by Professors Bo Vahlquist (Uppsala) and Raymond Mande (Paris). It took place at the National Institute of Public Health, and has raised great interest in the Ivory Coast.

On the 17th and 18th of November, a small working group, chaired by Professor Bo Vahlquist, studied what should be the content and form of a coordinated international research project on breast feeding, which would be organized in 1973 by the International Children's Centre, in cooperation with WHO, and which would begin in 1974.

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* Based on International Children's Centre Newsletter, Vol. XVII, No. 13, December 19, 1972.

DAG HAMMARSKJOLD SEMINAR ON "COMMUNICATION - AN ESSENTIAL COMPONENT IN DEVELOPMENT WORK"

The seminar took place in Uppsala, Sweden, 27 August to 9 September 1972 and was held as a follow up of the 1971 Dag Hammarskjold Seminar on "Nutrition as a Priority in African Development" (see PAG Bulletin Vol. II, No. 1, p. 34).

A weakness in all development programs including nutrition programmes is in the information and communications aspect. Its recognition of late, has led to more information activity built into development programs. Information activities can tune people into new opportunities in the social and economic environment - and explain the benefits to them. Unless carefully projected, information may just wash over people as waves of undifferentiated static.

Communication is a two way process requiring that people have the means to talk back. Thus the development worker listens and uses the feedback continuously to shape the programme. It is only through this kind of dialogue that development projects become meaningful to people in a specific situation and, more pregmatically, how they succeed over time.

Mr. Bert Lindstrom, Deputy Administrator of UNDP gave the opening address to the seminar and emphasized the need to involve all the concerned people from the very beginning through an effective communication program.

The programme was organized into the following main sections: social change in Africa and Scandinavia; communication planning and implementation; management and communication; the importance of creativity; and the total communications campaign. Papers were presented on social change in the past and on questions of information and development in the present. Some of these were on introducing new knowledge in the village, the problems in bringing about change and role of foreign experts in developing countries with special reference to communication with government authorities and with the people. The discussions that followed brought out clearly that the communication problems existed among the change agents as well as the program recepients. The tools available to communicators were discussed and the presentation "Communication by visual aids - from perception to creativity" by Dr. Fugelsang, the seminar Director, placed special emphasis on the need for preliminary field testing, a form of feedback. Opportunities were given to observe work at two advertising agencies in Stockholm. The visits made it clear that the impact of a message depends heavily on creative use of the media. Several campaigns were studied and discussed, such as the Swedish campaign to switch to driving on the right, the family planning campaign (Nigeria) and the national nutrition education programme (Zambia).

The seminar included some unusual activities in the form of communication experiments and communication game in the form of planning and running an agricultural extension campaign The participants of the seminar were very senior civil servants, all from English speaking countries in Africa and represented Departments dealing with information services including mass media and communication training.

The Dag Hammarskjold Foundation has published two volumes of papers prepared by participants on information and education activities in their own countries, and a preliminary report on the seminar.

More information can be obtained from:

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Prepared from notes submitted by Annette Jere, Director, Public Relations Unit, The National Food and Nutrition Commission, P.O.B. 2669, Lusaka, Zambia.

TROPICAL PRODUCTS INSTITUTE : SOME CURRENT PROJECTS

Of great interest to many developing countries is the making of bread using "composite" flours. These flours contain a proportion of non-wheat flour and, where necessary, a protein supplement mixed with wheat flour. TPI has set up a test bakery at the Industrial Development Department at Culham to perfect techniques for the use of non-wheat flours for making bread and unleavened goods such as biscuits and "rotis". Two overseas projects, in Nigeria and Sri Lanka (Ceylon), have been started and in each case TPI staff have established an experimental bakery to continue research with local non-wheat flours in bread production. Meanwhile the scope of TPI's bakery is being expanded so that training and advice can be given on all aspects of cereal and bakery technology in developing countries. Similar efforts sponsored by FAO and the Dutch Government in Colombia have been reported in this Bulletin (Vol. III, No. 1, 1973).

The problem of the deterioration of freshwater fish in East Africa, and marine fish from West Africa, is being studied at TPI. The work indicates that major improvements in keeping quality can be achieved in the preservation of tropical species. TPI is also examining methods of utilising waste fish and fish offal as animal feeds.

Storage problems exist in developing countries associated with the recent introduction of new, high yielding cereal grains. Some of the newer varieties are more susceptible to damage during storage than those that they have replaced. Moisture relationships and insect resistance mechanisms are being investigated by TPI. It is hoped that this research will enable the plant breeder to produce high yielding varieties with good storage characteristics.

Heavy storage losses occur in food grains stored by peasant farmers for their own consumption. The total quantity of grain stored by small farmers in developing countries is enormous. Simple storage structures and infestation control techniques have been developed to combat these losses. As these techniques are perfected it is essential that the farmers are encouraged to use them; this is being done through Storage Extension Projects mounted in a number of developing countries by certain voluntary organisations in collaboration with the Institute.

TPI publishes numerous technical, economic and marketing reports on tropical produce, as well as small industry studies. In addition it produces a Biennial Report, the quarterly journal "Tropical Science", a fortnightly "Library Bulletin of Accessions", the six monthly "Oil Palm News" and "Tropical Stored Products Information" as well as occasional Bibliographies, and the "Crop and Product Digests" series. A list of publications is available from the Institute.

This Institute is part of the Overseas Development Administration, Government of United Kingdom and gives advice and carries out research on the various scientific, technological and economic problems that arise during the processing, preservarion, storage, marketing and utilisation of these resources. TPI has a staff of about 350 working in the Institute and overseas and the 1972/73 budget is over $2,500,000. Further enquiries on TPI may be sent to: The Director, Tropical Products Institute, 127 Clerkenwell Road, London EC1R 5DB.

Excerpts from: Aid for Development, Fàct Sheet, Foreign and Common Wealth Office, Overseas Development Administration, London, October 1972.

L. I. F. E.:

NUTRITION AND PRODUCTIVITY: THEIR RELATIONSHIP IN DEVELOPING COUNTRIES

This publication summarizes the information obtained from questionnaires sent out to organizations with employee nutrition programs, mostly in developing nations. Two hundred and seventy-two questionnaires were sent out with a 28% response. The replies contained "little hard data and the replies were generally imprecise and subjective by scientific standards". Nevertheless, the information obtained showed useful insights and experience and confirmed the lack of real-life data on nutrition and productivity. Although there is no doubt that feeding the malnourished will improve performance, the publication points out the gaps in knowledge that must be filled for relating nutrition and productivity in a more quantitative manner.

L. I. F. E. 1972. Nutrition and productivity: their relationship in developing countries. League for International Food Education, Washington, D. C., U. S. A.

H. H. Gifft, M. B. Washbon and G. G. Harrison:

NUTRITION, BEHAVIOR AND CHANGE

Although research has demonstrated the nutritional needs of individuals and the causes of malnutrition, the outstanding problem at present is how to apply this vast pool of knowledge to promote beneficial nutritional practices and prevent ill health. Successful application requires a thorough understanding and comprehension of why people eat what they eat - "human food-ways" of the society and the food habits of individuals - and interweaving the nutritional knowledge within the framework of the sociocultural pattern of eating. This is what this excellent book is all about.

Using largely the United States as an example, the authors describe very effectively the background of the prevalent "food-ways" and food habits of the population, the non-food factors influencing them and the effects of such behavior on the health and welfare of the people. A large amount of factual information is presented in an interesting way without recourse to dry statistics. There is some repetition in the material contained in the various chapters, which is probably unavoidable. Each chapter ends with a long list of references and a list of additional reading material.

Gifft, H. H., M. B. Washbon and G. G. Harrison. 1972. Nutrition, behavior, and change. Prentice - Hall, Inc., Englewood Cliffs, N. J., U. S. A. 392 pp.

G. H. Bourne, ed.:

WORLD REVIEW OF NUTRITION AND DIETETICS, VOLUME 13

This volume contains the following six articles: the world protein shortage: prevention and cure; reversible and irreversible effects of protein-calorie deficiency on the central nervous system of animals and man; nutritive state of the population of Spain; individual dietary surveys: purposes and methods; thermal processing of foods: a review; nutrition and dialysis; and nutritional influences on periodontal disease.

The article "World protein shortage: prevention and cure" by A. A. Woodham emphasizes the importance of undertaking integrated long-term planning and programs which make use of all available avenues for solving the problem. The shortage, currently at least,is to a large extent the result of maldistribution, partly due to unavailability and partly to lack of demand, unequal consumption and improper utilization.

The article on the effects of protein-calorie deficiency on the central nervous system reviews the results of studies on animals and man separately and examines the practical implications of these findings.

Bourne, G.H. (ed.). 1971. World review of nutrition and dietetics. Volume 13. S. Karger, Basel, Switzerland. 308 pp. $23.50.

Checchi and Company:

FOOD FOR PEACE - AN EVALUATION OF PL 480 TITLE II
VOLUME I. A GLOBAL ASSESSMENT OF THE PROGRAM
VOLUME II. EVALUATIONS OF EIGHT COUNTRY PROGRAMS

These two volumes describe the results of an eight-month study undertaken on contract by Checchi and Co., Washington, D. C., for the USAID. Volume I, which provides a global assessment of the program, contains three parts. Part I covers the evaluation framework and includes background and historical data on Title II and the scope of work of the PL 480 Title II evaluation, the eight-country sample (Sri Lanka (Ceylon), Colombia, the Dominican Republic, Ghana, Indonesia, Malaysia, Morocco, and the Philippines), the design and organization of the study and the criteria for evaluation and their implications. Part II contains detailed results of the evaluation of Title II impact and is considered under maternal and child feeding programs, school feeding, food for work, other child feeding activities and other Title II programs such as adult institutional feeding, animal feeding and supplemental cash supports. Part III indicates the conclusions and recommendations covering policy, operation and administration.

Volume II contains the eight separate country evaluations based on field work undertaken which provided the material for the overall evaluation described in Volume I.

The overall conclusion of this evaluation is "that the PL 480 Title II program, as it now stands, is generally soundly conceived, well administered and making a significant impact on the economic and human development of recipient countries. Recommended changes arise primarily from observations of missed opportunities or less than full utilization of the potential inherent in the program".

Checchi and Company. 1972. Food for peace: an evaluation of PL 480 Title II. 815 Connecticut Ave., N.W., Washington, D.C. 20006, U.S.A.

Elizabeth Orr:

THE USE OF PROTEIN RICH FOODS FOR THE RELIEF OF MALNUTRITION IN DEVELOPING COUNTRIES - AN ANALYSIS OF EXPERIENCE

A longstanding preoccupation of the PAG has been encouragement and guidance in the development and use of protein rich foods for the relief of malnutrition in developing countries. This monograph which had the financial support of the PAG was written and published by the Tropical Product Institute on behalf of the Group. It reviews the experience of the last two decades, the failures and successes, and makes recommendations helpful for future efforts.

It is presented in five sections: introduction, protein rich food schemes, some aspects of the same, evaluation of this approach, and initiation of new schemes with guidelines for government administrators. The report closes with references and statistical Appendix.

For copies, please address the Tropical Products Institute.

Publication No. G73, Tropical Products Institute, 56/62 Gray's Inn Road, London, WC1, 8LU, August 1972, 71 pages.

L-A Appelqvist and R. Ohlson, eds.:

RAPESEED CULTIVATION, COMPOSITION, PROCESSING AND UTILIZATION

Rapeseed is an important oilseed crop whose nutritional potential has been overlooked in discussions on the world food situation. This probably is due to several misconceptions about its utility largely resulting from insufficient research on the various utilization aspects of this important crop. During the last decade there has been a spurt in research activity particularly in Canada and several European countries which has led to a realistic appreciation of the role of rape seed as an important agricultural commodity and a valuable source of vegetable oil and protein.

This monograph reviews the results of all recent studies mainly carried out in Canada and Europe on the cultivation, composition, processing and utilization of this crop. Fourteen out of the 15 chapters in the book are written by Swedish authors. Each chapter is followed by an extensive bibliography.

MATERNAL NUTRITION AND THE COURSE OF PREGNANCY

"Nutricion de la Madre y el Curso del Embarazo" is a Spanish version of the publication, "Maternal Nutrition and the Course of Pregnancy", Summary Report, by the Committee on Maternal Nutrition/Food and Nutrition Board, National Research Council, National Academy of Sciences.

Limited numbers of copies may be obtained upon request from:

The Office of Nutrition
Technical Assistance Bureau
Agency for International Development
Department of State
Washington, D.C. 20523

UNICEF AIDS NEW HIGH - PROTEIN INFANT FOOD PROJECT IN CAIRO

A new Egyptian infant-food plant - a joint effort of the Government of Egypt, the United Nations Children's Fund (UNICEF), the Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the World Food Programme (WFP) - was formally inaugurated on 17 March in Cairo.

The production of 1,000 metric tons of Supramine* per year, an infant weaning food with 20 per cent protein content, sufficient to feed 50,000 babies for 8 months, is the goal of the new plant.

The Supramine plant has been built by the Nile Pharmaceutical Company, a government-owned corporation who will manage and operate it. UNICEF has equipped the plant at a cost of $US 445,000 with milling, mixing, filling and packaging equipment, spare parts, in addition to the main production line. The Fund has also provided an initial supply of vitamins, enzymes and food flavourings.

The two main components of the food mixture - hard wheat flour and dried skim milk - are being provided by the WFP. Over the next five years, WFP will provide foodstuffs, estimated to cost $US 1,003,000. The other three raw materials used in the mixture - chickpeas, lentils and sugar - are being supplied by the Egyptian Government from locally available stocks.

Through government health centres the food will be distributed free to mothers. It will also be sold in 300 gm, packages (a five days' supply) for 10 piastres (22 US cents) through government-run pharmacies, thus making available for the first time at a reasonable cost a nutritionally-sound weaning food.

Supramine has been tested and modified to make its texture, colour and flavour acceptable to Egyptian mothers and infants. Using film-strips, posters and leaflets designed with FAO collaboration, a national campaign - also using radio and television - is promoting the new food's use.

Extract from UN Press Release March 1973.

COFFEE PULP AS ANIMAL FEED

In Central America large quantities of coffee pulp left over from the production of soluble coffee are currently being dumped or allowed to decompose in the open, causing a public health problem. There are significant amounts of protein and other nutrients in dehydrated coffee pulp which can replace grain by-products as a component of animal rations. The levels of toxic elements, however, need to be reduced through the development of appropriate processing procedures. The International Development Research Centre announced in March 1973 a grant to support research at the Institute of Nutrition of Central America and Panama (INCAP), located in Guatemala, to study ways of solving problems of toxicity which currently restrict the use of this pulp, and to increase the level at which it can be fed in animal rations.

From International Development Research Centre News - No. 06/73.

* A similar food mixture is being produced in Algeria under the name Superamine.

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6	PAG Statement on milk substitutes	1970	
7	PAG Recommendation on prevention of food losses and protein-calorie malnutrition	1969	
8	PAG Statement on plant improvement by genetic means	1970	
9	PAG Recommendation on amino acid fortification of foods	1970	
10	PAG Statement on a systems approach to the formulation and evaluation of nutrition intervention programmes	1970	
11	PAG Statement on leaf protein concentrate	1970	
12	PAG Statement on the world protein problem: research and development needs	1971	No. 12
13a	Review of the specific proposals contained in ACAST report "International Action to Avert the Impending Protein Crisis" United Nations, 1968	1971	
14	PAG Statement on marketing of conventional foods	1971	No. 12
15	PAG Statement on popular participation and community involvement in nutrition improvement programmes	1971	
16	PAG Statement on the potential of fish protein concentrate for developing countries	1971	Vol. II, Nos. 2 and 3
17	PAG Statement on low lactase activity and milk intake	1972	Vol. II, No. 2
18	PAG Statement on relationship of pre- and postnatal malnutrition in children to mental development, learning and behavior	1972	Vol. II, No. 2
19	PAG Statement on maintenance and improvement of nutritional quality of protein foods		
20	PAG Statement on the "protein problem"	1973	Vol. III, No. 1
21	PAG Statement on specifications for solvents	1972	
22	PAG Statement on upgrading human nutrition through the improvement of food legumes	1973	Vol. III, No. 2
23	PAG Recommendations for the promotion of processed protein foods for vulnerable groups	1972	Vol. II, No. 3

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4	PAG Guideline for preparation of edible cottonseed protein concentrate	1970	
5	PAG Guideline for edible, heat-processed soy grits and flour	1969	
6	PAG Guideline for preclinical testing of novel sources of protein	1970	
7	PAG Guideline for human testing of supplementary food mixtures	1970	
8	PAG Guideline on protein-rich mixtures for use as weaning foods	1972	
9	PAG Guideline on fish protein concentrate	1971	No. 12
10	PAG Guideline on marketing of protein-rich foods in developing countries	1971	
11	PAG Guideline for the sanitary production and use of dry protein foods	1972	Vol. II, No. 3
12	PAG Guideline on the production of single cell protein for human consumption	1972	Vol. II, No. 2
13	PAG Guideline for the preparation of milk substitutes of vegetable origin and toned milk containing vegetable protein	1972	Vol. III, No. 1
14	PAG Guideline on the preparation of defatted edible sesame flour	1972	Vol. III, No. 1

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No.	Title	Date
1.	Feeding the preschool child: report of a PAG *ad hoc* working group	1971
2.	Manual on feeding infants and young children (Cameron and Hofvander)	1972

PAG Statements and Guidelines may be used and quoted freely. Please note that some of these have been published, as indicated, in previous issues of the PAG Bulletin. Single copies may be obtained without charge from the Protein Advisory Group of the United Nations System, N. Y. 10017, U. S. A. This material may be reproduced for personal use.

The Pan American Sanitary Bureau has translated PAG Statements 1 through 18 into Spanish. They are published in that organization's Bulletin Vol. LXXIII, No. 5, November 1972. Requests for this issue of the publication should be directed to:

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